GRUMMAN HORIZONS

SPRING 1963

HOW FAR WE'VE PROGRESSED *in marine transportation is dramatically illustrated in this contrasting study of Grumman's 63-kt Denison, hydrofoils upraised, and H.M.S. Bounty of MGM's Mutiny on the Bounty.*

Vol. 2, No. 1 Spring 1963

IN THIS ISSUE

COVER STORY: Lunar rendezvous and docking simulator is being "flown" inside Grumman's familiar blue ball trademark atop Plant 5 **(photo left).** Former radome has been converted into planetarium for space rendezvous experiments—symbolic of Company's advanced role in manned spacecraft field now that it will build Lunar Excursion Module (LEM). Astronaut model is Charles Belensky, Grumman instrumentation engineer, who designed devices that project mother ship image **(back cover)** and star field **(note Big Dipper handle intersected by mother ship).** Belensky's right glove was removed to display three-axis fingertip control.

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you can help SAVE OUR STRIPS!

by Najeeb E. Halaby, Administrator, Federal Aviation Agency

Shopping centers, housing developments, and other lucrative real estate projects are gobbling up private airports in our metropolitan areas. As airports disappear, so do industries—relocating elsewhere. What the private citizen can do—and the government is doing—about our national airport "tragedy" is explained in this article by the government's civil aviation chief, Najeeb E. Halaby.

DISEMBARKING *from an FAA aircraft after personally piloting it to an aviation meeting, the author maintains his piloting proficiency as well as his close association with the industry he oversees. A former commercial pilot instructor for the Army Air Corps, Halaby became chief instructor for the Navy's first test pilot school during World War II. Later he joined Lockheed Aircraft Corp. as a test pilot and flight-tested the first operational American jet airplane, the Lockheed YP-80. He also made the first continuous transcontinental jet flight in this country. "Jeeb," 47, has held high positions in the State and Defense Departments and with NATO.*

The nation's airmen can continue to fly safely and efficiently—and flying can reach its great potential—only if they have a sound base of operations on the ground. To meet this goal, we must provide new airports at many smaller communities and solve the problem of the disappearing private airport in the metropolitan areas.

The national airport system is aviation's ground base. It must provide enough facilities in sufficient variety to serve all the diverse elements in the national aviation system. And this airport system must be improved and expanded to meet the dynamic growth pattern predicted for the '60s, especially in general aviation.

Project Horizon's report on national aviation goals predicted that the general aviation fleet will increase from about 80,000 aircraft in 1962 to 105,000 by 1970. To handle this growth, many new general aviation airports must be added to the system by 1970. Yet at a time when there is a clear need for expansion, we are having trouble holding on to all the airports we have in the metropolitan areas now.

The trend toward loss of these private airports must be reversed. It's a job for all aviation interests, united in a common effort, to generate the local community understanding and support that is vital to the economic growth and development of this nation.

The Federal Aviation Agency plays a major role in this effort. We supply financial help through the Federal Aid Airport Program. Congress appropriated $75 million each for fiscal years 1962 and 1963 and has authorized another $75 million for fiscal 1964. These funds are matched with local money to help communities plan, develop, and improve their airports.

Under this program, the FAA annually prepares a National Airport Plan which estimates improvements to present airports and the number of new facilities that will be needed over the next five years. An airport must be listed in this plan to be eligible to apply for federal financial aid. It also must be officially sponsored by the community involved—private airports are not eligible for federal aid under any circumstances.

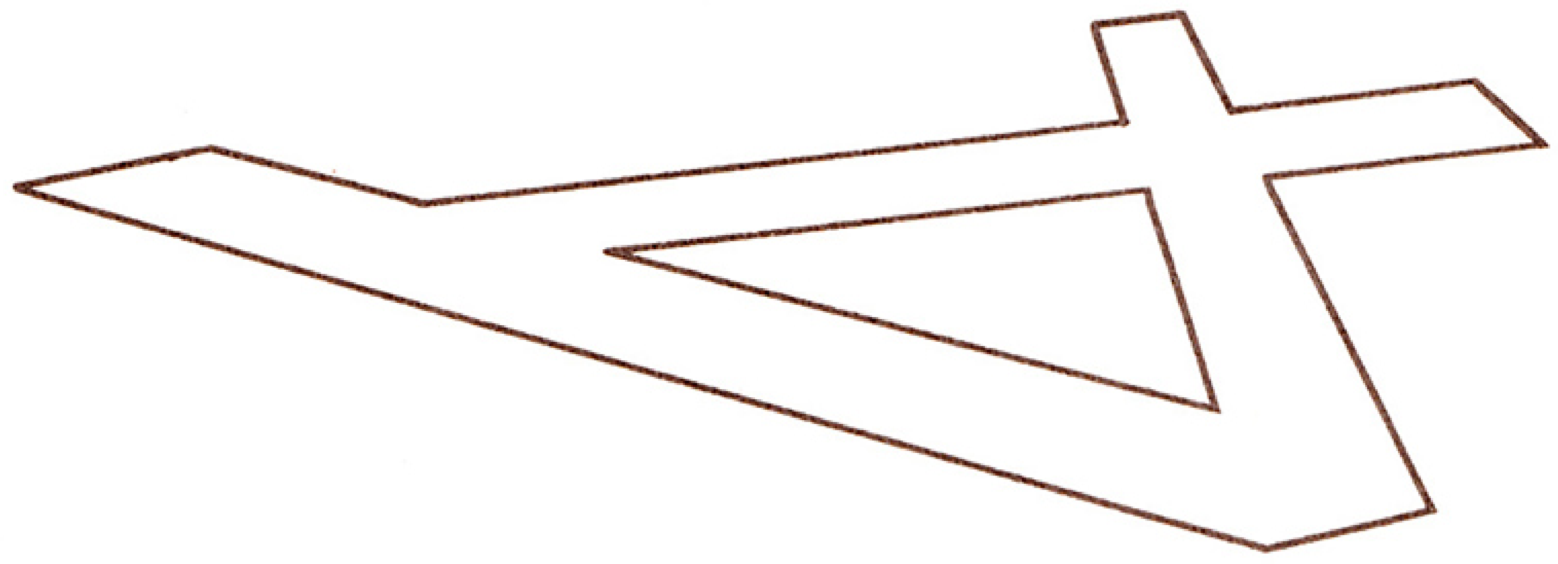
The current National Airport Plan includes 3388 facilities. It singles out 250 general aviation airports which should be built or improved in 59 metropolitan areas. A special fund of $7 million has been set aside annually, since fiscal 1962, under which these airports get first priority in the national plan.

In addition to financial help, the FAA provides public and private airports alike with technical advice. There are 29 District Airport Offices located across the nation and available to anybody who needs help. And now, instead of waiting for requests for financial and technical aid to come in, the FAA is volunteering aid to communities in critical areas. This change has been made in order to hasten airport work in places where it might languish while waiting for local officials to recognize the need.

The Agency also is revising its standards into a more flexible code which will permit communities to tailor their airports more closely to their requirements. And discussions have been launched with the Department of Commerce to determine how airport and road building programs could be more intelligently integrated.

But in spite of federal programs and parallel aviation efforts, local initiative and support remains the controlling factor. Without it, we will see a growing list of disappearing airports in place of the expanding system we need so much.

The major terminals required by the airlines do not face this problem. The role of an airport in the economies of the larger cities is clearly defined and generally accepted. The opening of Dulles International Airport last November as a new jet gateway to Washington is only the



latest in a nationwide chain of improvements.

It's in the smaller fields that we're hurting. In some cases, local support is not sufficient to maintain a local airport. The community is not aware of the field's present benefits and of the increasingly important economic contribution it can make as industry continues to diversify. With the trend to diversification, and a parallel growth in business use of airplanes, an airport can be the critical factor in a city's campaign to lure new industries or hold present ones.

In other cases, the private airport operator sees the city grow out around his boundaries, increasing his land's value, raising his taxes, and offering him a quick profit if he converts the field to a shopping center or a housing development. Real estate encroachment has been a prime cause of airports disappearing.

The loss of Mitchel Field to aviation is a classic example of what can happen when the local community fails to recognize its need for an airport. This Air Force base in Nassau County (Long Island), New York, was declared surplus to military needs. Nassau County business and aviation interests, strongly supported by the FAA, attempted to preserve a portion of the Mitchel complex as a general aviation airport.

The field is ideally located to serve general aviation in the easterly section of the New York metropolitan area. It had a replacement value of $10 million, and it is estimated that the airport would have produced an annual aviation payroll of $1.5 million. It could have been acquired at no cost and, under proper management, it could have operated at a profit.

Other interests in the area were determined to have Mitchel Field for cultural, educational, and business purposes, and they refused to include an airport as part of their plan. Because of the heavy pressure brought to bear and its political repercussions, no local political authority would come forward to sponsor the airport. It was lost through lack of adequate community support. The Federal Government is disposing of it for nonairport purposes.

When Nassau County awakens to the need for a general aviation airport and is ready to do something about it, Mitchel Field will be gone. Producing a new field will be much more painful, of course, than converting an existing airport would have been.

Chicago's Midway Airport also went through a trying siege of local antagonism, but fortunately the atmosphere changed and the airport is now welcomed as an important economic asset. Once the world's busiest airport, Midway had to contend with a stream of complaints from its neighbors, including loud protests against the problem that plagues many an airport manager—noise. The local citizens were against introduction of jets to Midway.

The city had built O'Hare International Airport to meet the requirements of the jet age. Suddenly, all airline operations shifted to O'Hare with the jets and Midway was a veritable aviation ghost town. The local community quickly recognized the economic importance of the airport and switched from protest to support. Now Midway is a busy general aviation airport and will be used again by airlines as O'Hare becomes inadequate.

Midway is an unusual example of a general aviation airport, but it illustrates how the economic contribution of an airport can go unrecognized and unsupported until it is removed from the scene. Too often, this recognition comes too late to save an airport.

Local understanding and support is helpful beyond the issue of survival, of course. Public authorities can do much to enhance an airport's safety and help it live amicably with its neighbors. Zoning can be used to keep approach zones clear and to keep residential building away from runways to relieve noise problems.

FAA has taken two steps recently that should encourage development of small airports and at the same time reduce their costs. The first is the proposal of more flexible standards—standards that would permit a community to tailor its airport to its needs. Land requirements, for example, range from a minimum of 25 acres for the smaller Class I to 51 acres for the larger Class III. Runway widths have been significantly revised so that, by planning for the types of planes that will use a landing strip, it is possible to specify a more reasonable and practicable development.

The proposed FAA specifications for runways include three categories. Class I fields with 2200-ft lengths call for a minimum landing width of 75 ft; the Class II 3200-ft runway is 100 ft wide; and the 4200-ft Class III is 125 ft wide. For all, the minimum clear zone length is 1000 ft.

Our old philosophy and old criteria sometimes led a

community that sought matching funds to build an airport far more ambitious and expensive than it wanted or needed. FAA tested the new criteria on one general aviation airport where former criteria would have meant a half-million-dollar airport for a town of a few thousand people. FAA engineers, applying the new criteria, found that the town could build the kind of airport it needed, including adequate lighting and the same 3200-ft paved runway as in the original plan, for $106,000—or a saving of $208,000 each for the Federal Government and the local community.

The second step has been an effort to coordinate our airport programs more closely with highway programs. A proposal along these lines was made recently by FAA to the Secretary of Commerce, based on the thought that airports and highways should form an integrated part of a comprehensive national transportation system.

The plan, still in the preliminary stages, envisions close liaison between the Bureau of Public Roads and FAA's Airports Service. By integrating airport planning and highway planning, other benefits can be derived. Land acquisition costs can be reduced and, more important, construction costs cut. The same heavy equipment and the skilled labor needed to build highways could be used at nearby airport sites, and fringe costs—such as access roads, extension of power services, and drainage outlets—could be reduced. In general, future interstate highway planning will be examined to determine if new airports should be located along interstate routes. Any requests for new or improved strips by public agencies will be studied in the light of planned or pending highways.

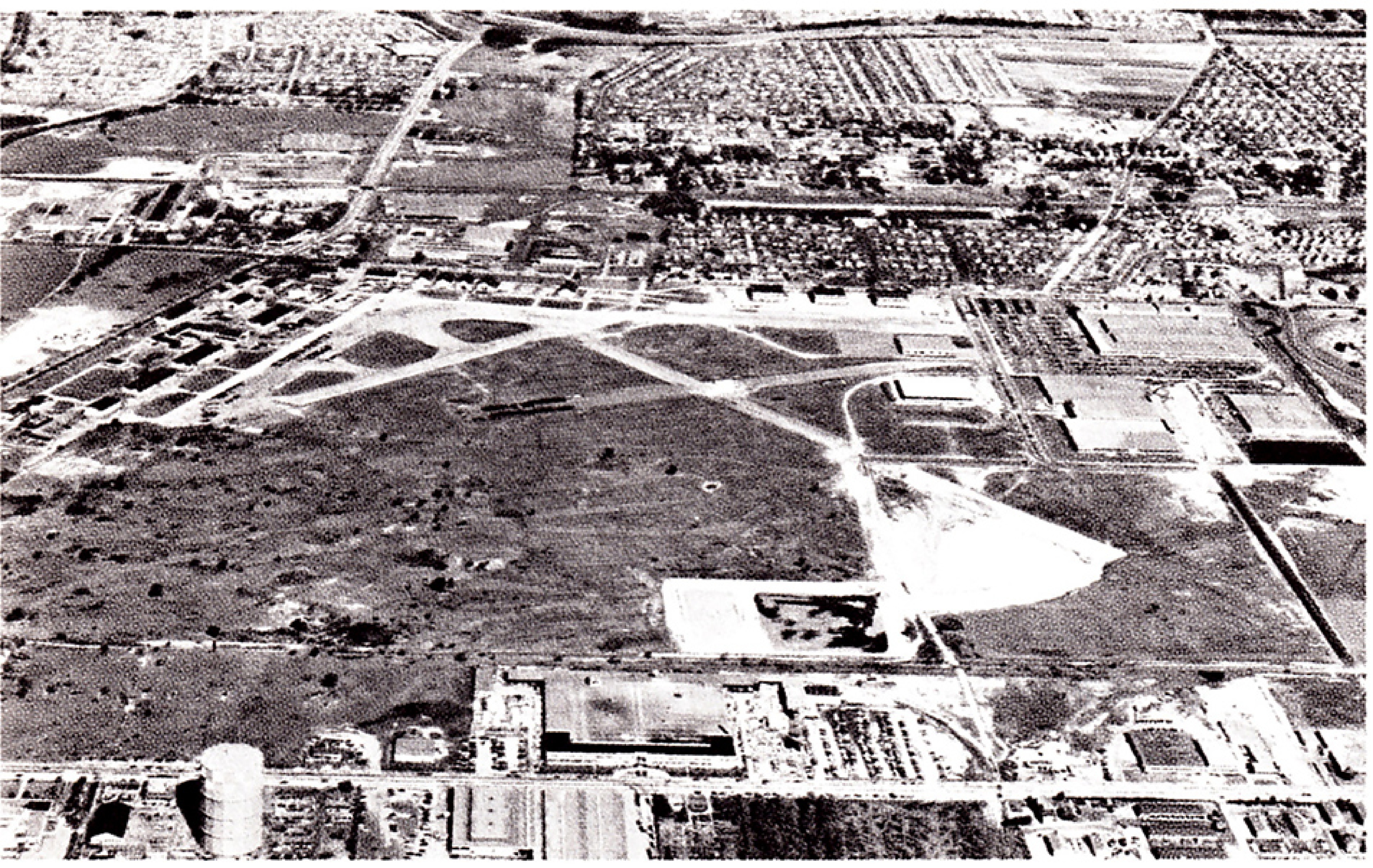
Many details will have to be ironed out and success of the program will depend on cooperative efforts and help from state aviation agencies and highway departments. The ultimate responsibility for success will rest, however, on communities that recognize the advantages in developing suitable facilities for rapidly growing general aviation.

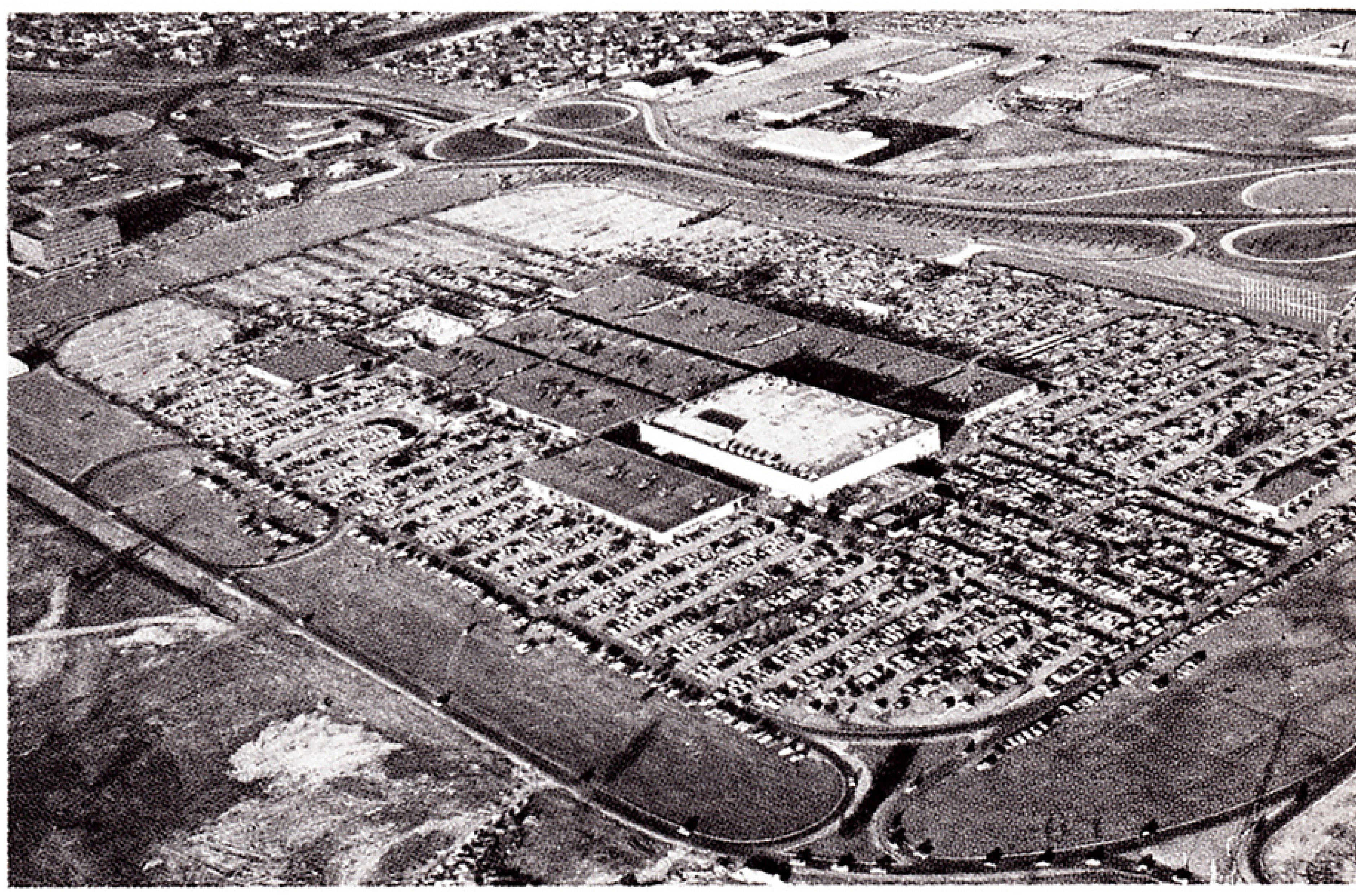
An excellent example of what a coordinated airport-highway approach can do for a state is evident in Oklahoma. There, the nontax-supported Oklahoma Turnpike Authority is planning to build strips adjacent to turnpikes.

The first of the county-sponsored airport-highway strips is now under construction at Chickasha. Land has been purchased for another to be positioned along the turnpike between Oklahoma City and the Texas state line at Walters, and a third is planned near Vinta.

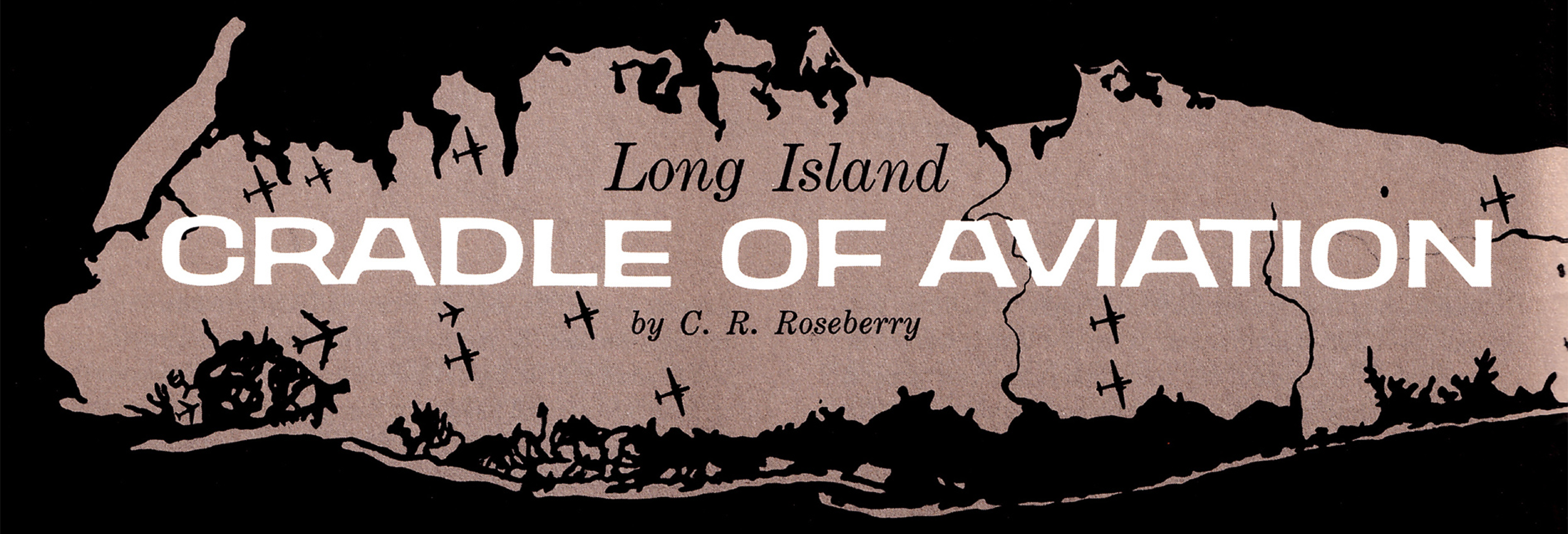
Certainly from the pilot's point of view, the proximity of surface transportation, motels, restaurants, and even highway service stations enhances the comfort and utility of his airplane, and the return to the community can be considerable.

If present airports are to be made safer and more efficient, and better new airports built, the whole aviation community must join in a common effort. No matter what the future brings in aircraft, there must always be airports to get the men and machines together. ■ ■ ■





BEFORE AND AFTER: *Historic Roosevelt Field as it looked in the late '40s and as it remains today, runways replaced by a shopping center.*



Long Island CRADLE OF AVIATION

by C. R. Roseberry

Flatlands for emergency landings, seaplane havens, and proximity to the big city attracted aviation pioneers

The elongated island Walt Whitman called "fish-shape Paumanok" was admirably fashioned by the Pleistocene ice to become a cradle and crucible of aviation.

The flat stretches of sandy plain in the interior made ideal landing fields. Almost anywhere would serve in an emergency in those early days when forced landings were routine. Close to the north or south lay the embracing water, conveniently notching the shorelines in coves and bays hospitable to "hydroaeroplanes." These natural attributes coupled with an enviable geographic location leave small wonder that the island became a terminus for so many historic flights, as well as a center for aeronautical industries.

Actually, American aeronautics is said to have been born at Castle Garden on the lower tip of New York City's Manhattan Island on Sept. 9, 1830. As related by Preston Bassett in his *Aeronautics in New York State**, Charles Ferson Durant, a 25-year-old New Yorker, made the first American ascension in an American-made balloon on that date. He drifted slowly over New York Harbor and landed at Perth Amboy, N. J., after being aloft two hours.

Long Island made its own aeronautical debut three years later, in June, when Durant landed at the Union Course racetrack at Jamaica, N. Y. According to Bassett, President Andrew Jackson watched as the balloonist ascended from Castle Garden and drifted over New York City and the Island.

The records show little activity on Long Island's aeronautical front from that date until Oct. 7, 1873. At 9:19 that morning, a large balloon with a boat suspended beneath rose from the Capitoline Grounds in Brooklyn. In the boat were three men hoping to be the first to cross the Atlantic by air—aeronaut W. E. Donaldson, navigator Alfred Ford, and *Daily Graphic* reporter George Lunt.

The balloonists were reported over Hempstead, L. I., about 11 a.m., then were lost from sight in clouds for several hours. Late in the afternoon, they came down out of the clouds to see where they were. Bassett explains:

"They were shocked to see that they were not over the ocean at all, but were being swept over woods and farmland. There was no use in continuing in the wrong direction, so Donaldson decided to land. But when they were near the ground, they found themselves being swept along too fast for a safe landing.

"Donaldson called for all hands to jump when they dipped to within 20 ft of the ground. Donaldson and Ford made the leap onto soft plowed ground, but Lunt held onto the ropes and was carried away. The balloon, having suddenly lost 300 lb of ballast, rose rapidly and disappeared. Donaldson and Ford found themselves in New Canaan, Conn., only 60 miles from their start.

"Later that evening word arrived that Lunt had disembarked frantically but safely into a treetop as the balloon careened over the top of a Connecticut ridge. The balloon went on alone and was never seen again. So ended the first aerial attempt to span the Atlantic. But

*Reprinted from NEW YORK HISTORY, quarterly journal of N.Y. State Historical Assn.

ABORTIVE *transatlantic attempt was made in 1873 by three balloonists who ascended from the Capitoline Grounds in Brooklyn. Blown over Connecticut by a strong wind, they "bailed out" safely in New Canaan.*

GLENN CURTISS *pusher biplane flies about 1910 over what was to become Hazelhurst (later Roosevelt) Field on Long Island.*

Long Island had been marked for a place in transocean flying history of which this was but the first faltering step."

More than a quarter century was to roll by before a famous aircraft pioneer finally recognized the aeronautical potential of Long Island. Glenn Curtiss found that building and selling the first commercial airplane in the U. S., the Gold Bug, wasn't enough. The $5000 contract also stipulated that Curtiss teach two members of the Aeronautical Society of New York, the buyer, to fly the biplane. Curtiss' trial flights at the society's makeshift field in the Bronx, the Morris Park Race Track, quickly proved the site was far from ideal. So club members drove him out on the Island where he spotted the Hempstead Plains, east of Mineola—"a nice flat place." There Curtiss and the Gold Bug made the flight that won him second leg on the Scientific American Trophy.

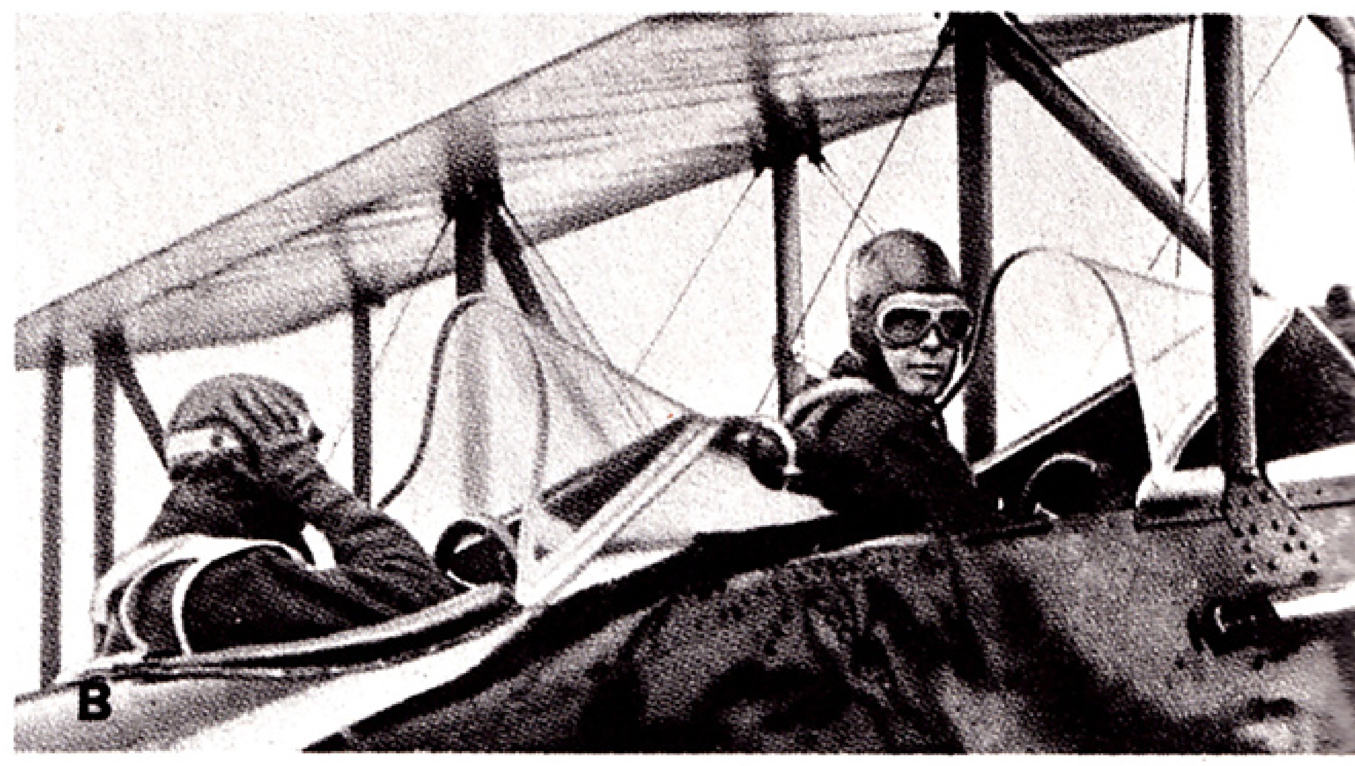
That day Curtiss planted the seeds of what later became Roosevelt Field—the most historic American airport of all time—and a long line of other notable fields and aircraft plants.

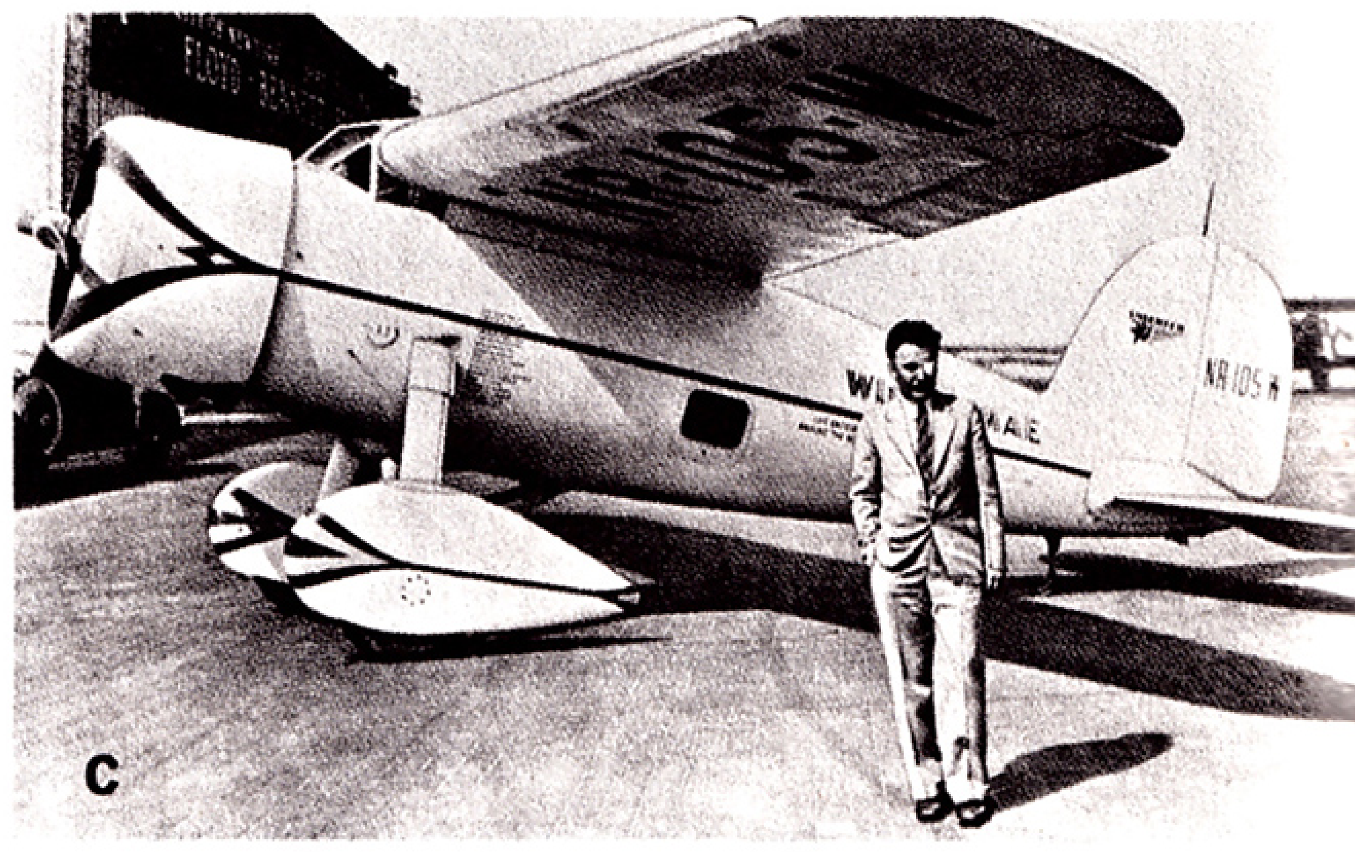
A wave of nostalgia among veteran airmen has been evoked in recent years by the abandonment of the two most celebrated fields—Roosevelt and Mitchel. Roosevelt's runways disappeared in 1951 to make way for a super shopping center named Roosevelt Field, Inc. There's a heliport now, and a Flight Mall where plaques remind you that "from this place" certain famous flights of yesteryear originated. This is where Charles Lindbergh may finally get his monument—denied him in his days of glory because a monument reaching skyward could be a hazard to flying. The Roosevelt Field Alumni Assn., with more than 200 charter members, hopes to have an Aviation Hall of Fame established somewhere near the vanished field, perhaps in Garden City.

The fate of neighboring Mitchel Field still is in doubt. It was deactivated as an Air Force Base in the Spring of 1961 after complaints about noise and danger of jets.

While Glenn Curtiss was pioneering flying on Long Island, the L.W.F. (Willard) Engineering Co. led the march of aircraft manufacturers out onto the Island. L.W.F. organized in 1915 with a plant at College Point on the East River, across Flushing Bay from what was to become LaGuardia Airport. The company specialized in a laminated wood monocoque fuselage and made the first plane to fly a Liberty engine. Later, L.W.F. remodelled many De Havillands for both the Army and the Post Office Department. Soon the Loening Aeronautical Engineering Corp., best known for its amphibians, opened shop in Long Island City.

dozens of airports and seaplane bases





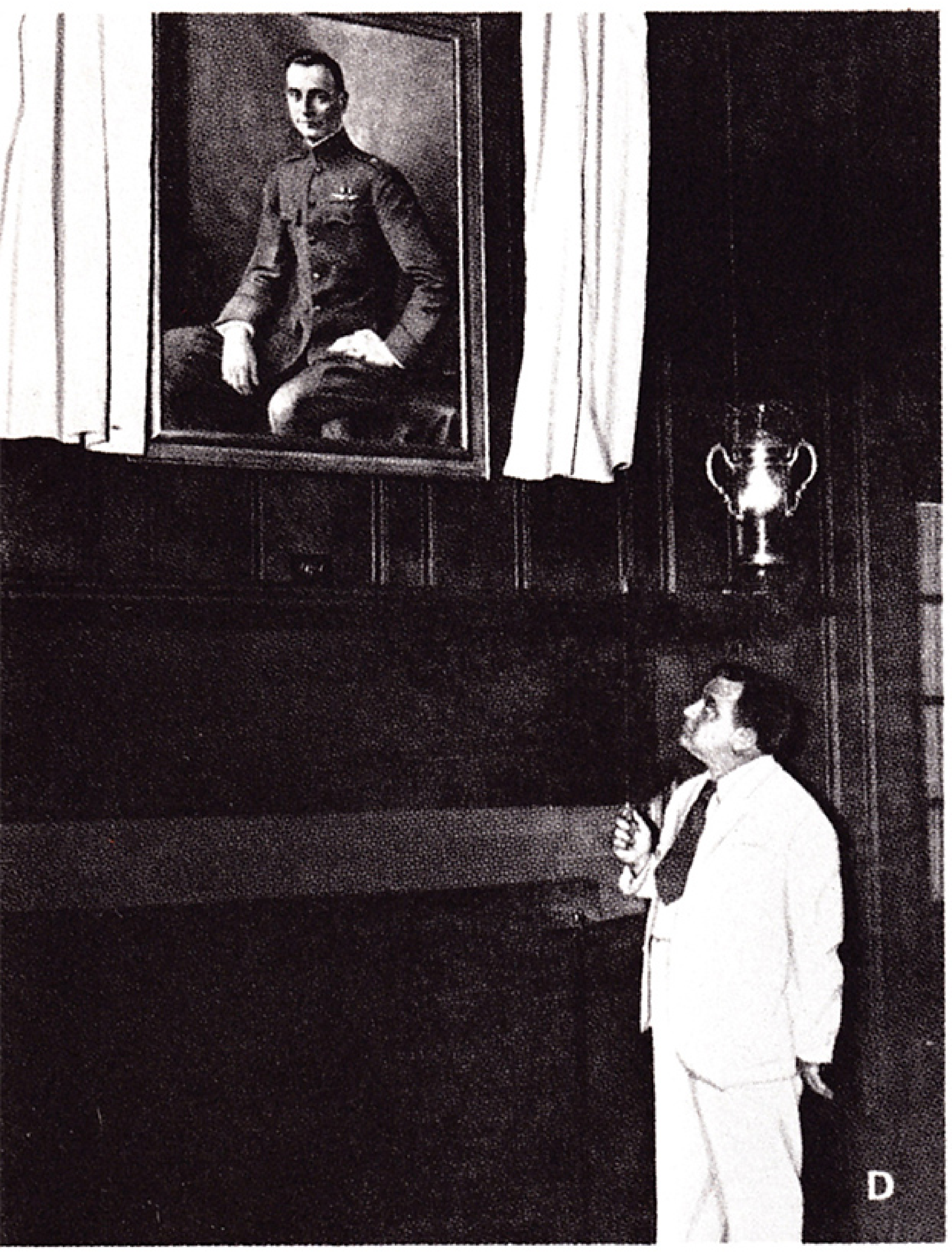
Shortly after the U. S. entered World War I, Glenn Curtiss opened a branch plant for experimental engineering at Garden City. By this time, Long Island was sprinkled with 18 fields and countless seaplane harbors. One reason for Curtiss' move was his plan to produce "hydroaeroplanes" on a large scale.

At Garden City, Curtiss built the big NC (Navy-Curtiss) flying boats, powered by four Libertys, for antisubmarine warfare. In May of 1919 the NC-1, NC-3, and NC-4 took off from the Naval Air Station at Far Rockaway, L. I., to attempt the first transatlantic flight. Only the NC-4 made it—reaching Lisbon and Plymouth. In July of the same year, the British dirigible R-34 made the first east-west air crossing of the Atlantic, nosing down to a mooring at Roosevelt Field. Several days later it left Roosevelt for the first roundtrip.

This Roosevelt, the field that amateur pilots had kept alive, had come to be known variously as the Mineola Air Field or the Hempstead Plains Aviation Field. The Army had taken it over in 1916 and renamed it Hazelhurst Field, in honor of the first noncommissioned officer killed in an airplane accident. Lt. Quentin Roosevelt had learned to fly at Hazelhurst. Roosevelt, the son of former President Theodore Roosevelt, was killed flying over the trenches of France, and Hazelhurst was renamed in his memory in 1919.

Meanwhile, the Curtiss Aeroplane and Motor Corp. developed its own test field, separated by a steep 20-ft incline from the higher Hazelhurst Field. As the Army Air Service hastily expanded during World War I, airport sites were selected in many places on Long Island. It was announced in mid-1918 that four new ones were about to be opened. Officers stationed at Hazelhurst named them: one at Wantaugh for Major Raoul Lufbery, the ace killed leaping from his burning plane; one at Babylon was to be Henry J. Damm Field for Lt. Col. Damm, killed in France that May; one near Commack for Lt. Col. C. G. Chapman, also a casualty of aerial combat.

But the naming of Field No. 2, just east of Hempstead, was the most lavishly publicized. This was to be Mitchel Field. Its namesake was Maj. John Purroy Mitchel (some have erroneously assumed the honor to belong to Gen. "Billy" Mitchell). Maj. Mitchel was a young attorney who became an enormously popular reform (or Fusion) mayor of New York City during the teen years. When Tammany finally defeated him, Mitchel enlisted and went into Air Service training. A single-seat scout plane he was flying at Gerstner Field, Lake Charles, La., somehow



(A) LAWRENCE SPERRY *gets ticket from motorcycle policeman for landing his Sperry Messenger biplane on a street in Long Island City in 1921 and taxiing to his house.*

(B) CHARLES LINDBERGH *made many flights from Long Island in his Loening biplane. His rear cockpit passenger was Trubee Davison, Assistant Secretary of War for Aviation.*

(C) WILEY POST *stands in front of his Lockheed Vega Winnie Mae at Floyd Bennett Field in 1933. The photo was taken just before his solo flight around the world with the first model of the modern automatic pilot, a Sperry.*

(D) MAJ. JOHN PURROY MITCHEL'S *portrait is unveiled by Mayor LaGuardia. After Major Mitchel (for whom Mitchel Field was named) was defeated by Tammany for re-election as New York Mayor, he enlisted in the Air Service. Later, a scout plane he was flying somehow rolled over on its back and he plunged 500 ft to his death. His safety belt hadn't been fastened.*

turned over and he fell to his death from an altitude of 500 ft. His safety belt had not been fastened.

With the end of the war, most of the military fields were unloaded and some reverted to commercial status. The Army retained Mitchel Field, however, and it was to gain renown in many Army distance and speed flights. It was here that Maj. "Jimmy" Doolittle carried on his pioneering blind-flight experiments.

After the 1919 outbreak of ocean flights, there came a lull of several years in such activity, and the Orteig $25,000 prize for a New York-Paris flight found no takers. But destiny had her sights trained on Roosevelt.

Tragedy struck first. In 1926, Capt. René Fonck, the French war ace, tried it with a Sikorsky S-35 built especially for the task by Igor Sikorsky at his Long Island plant (College Point). In the takeoff run, the S-35 failed to break ground. Plunging into a ravine past the end of the runway, the plane exploded and burned. Fonck and his co-pilot escaped, but the two other crew members were cremated. Flying the mail over the Midwest, Charles A. Lindbergh puzzled over the disaster.

The following May, Lindbergh flew across the country. He gives us some observations on the alternative fields awaiting him in his book, *The Spirit of St. Louis:*

"Ahead, beyond those suburbs on Long Island, lies the field from which I'll start for Paris. Will it be Curtiss, Roosevelt, or Mitchel? How long a run will I have? What obstacles must I clear? . . . I bank to circle all three, while I study the size and surface. Mitchel is better kept than the others; after all, it's an Army field. But, except near the center, the sod looks rough as I pass over it . . . and Curtiss, where I'm about to land, is much too small for a heavy-load takeoff. Roosevelt is large enough, and it's the only one that has a runway—a long, narrow affair, laid out approximately east and west . . . Yes, I'll take off from either Roosevelt or Mitchel. I can't decide which until I've walked over them several times . . . The runway on Roosevelt Field is close to a mile long—it's really the only place for a heavily loaded takeoff. Byrd has a lease on the field, but I can probably get permission to use the runway when he doesn't need it himself . . . a tendency to softness, and I wish it were a little wider; but on the whole it will give me a longer and better takeoff run than I expected to find anywhere around New York."

After Lindbergh's epic Roosevelt-to-Paris flight (May 19-20, 1927), great names blaze across the annals of Roosevelt Field: Chamberlin and Levine; Byrd, Acosta, Balchen, and Noville; Ruth Elder; Frank Hawks; Col.

(A) FLOYD BENNETT (left) *and Bernt Balchen pose in 1928 in front of the Fokker trimotor in which Balchen flew the Atlantic with Cdr. Byrd later that year.*

(B) SKIS *on Ford trimotor are adjusted by Balchen* (bending over) *while Bennett watches. Bennett died of pneumonia while on a rescue mission with Balchen.*

(C) LT. JIMMY DOOLITTLE, *shown in a Laird biplane, made the first completely blind takeoff and landing at Mitchel Field in 1929.*

Roscoe Turner; Maj. Kingsford-Smith; Laura Ingalls; Ruth Nichols; Wiley Post and Harold Gatty.

An atmosphere, a segment of life, a fraternal bond grew up around Roosevelt Field that possibly has never been duplicated elsewhere in the history of flying. It glows in the spirit of the Roosevelt Field Alumni Assn. Its president is W. D. (Jim) Guthrie, the man who managed the field for 25 years and now is living in retirement.

These oldtimers have such nostalgic memories as the "longest poker game in aviation history". Usually held in a hangar, the game was more-or-less continuous. When a player – perhaps Bert Acosta or Casey Jones – was cleaned out, he would lay his cards facedown on the table, go out and drum up a customer for a flight to raise funds, and finally return and pick up his hand.

The story is told that Casey Jones, Curtiss Field manager, once had aces back-to-back. He left them lying, and everyone respected his hand until he came back.

Long Island also shared the exploits of other aviation greats like Chance M. Vought, Giuseppe Bellanca, Vincent Burnelli. There was Elmer Sperry, without whose instruments flying would not have come of age. Although Sperry Gyroscope was no farther out on the Island than Brooklyn, Sperry's son founded the Lawrence Sperry Aircraft Co. at Farmingdale. This city also became the site, in the mid '20s, for the Fairchild Airplane Manufacturing Corp. Somewhat later, Republic Aviation Corp. arose at Farmingdale. And Grumman Aircraft Engineering Corp. began at Baldwin, L. I., in 1929.

At last, with Clarence Chamberlin as its technical consultant, New York City developed a municipal airport of its own out of marshlands and rubbish heaps on the Brooklyn edge of Jamaica Bay. It was opened in 1931, and named for an aviation martyr, Floyd Bennett, who was Byrd's co-pilot to the North Pole. When the German plane, *Bremen,* crash-landed in Labrador after the first east-west aircraft crossing of the Atlantic, Bennett and Bernt Balchen, both with influenza, volunteered to fly a rescue mission. At a landing en route, Bennett collapsed and was rushed to a Quebec hospital where he died of pneumonia.

Floyd Bennett Field was liked by pilots, but it couldn't

win the eastern airmail terminal and the big airlines away from already well-established Newark (N. J.) Airport. The transit from the far limits of Brooklyn to Manhattan was more difficult than from Newark.

But a hot-spoken little man named Fiorello LaGuardia became Mayor of New York. He had been a World War I bomber pilot and, while in Congress, an ardent champion of "Billy" Mitchell. Now he took up the cudgels to get New York City properly on the air maps.

One day in 1934, a Transcontinental & Western Airlines DC-2 landed at Newark Airport. Nine passengers left the plane, but one remained stoically in his seat. It was LaGuardia. Finally the stewardess went back and gently reminded him: "This is Newark, sir."

"So it is," the Little Flower agreed. "But it isn't New York, and my ticket says New York." He waved the ticket, pointing to the words "Chicago-New York."

TWA and airport officials went into a bewildered huddle. Phone calls were made and legal opinions sought. Reporters grew inquisitive. In the end, TWA surrendered meekly. The DC-2 took off and flew into Floyd Bennett Field with Mayor LaGuardia as its only passenger.

This was the opening gun in the battle LaGuardia waged for the airport that now bears his name. He tried to pressure the Post Office Department into changing its mind about Bennett. Failing that, he took other steps.

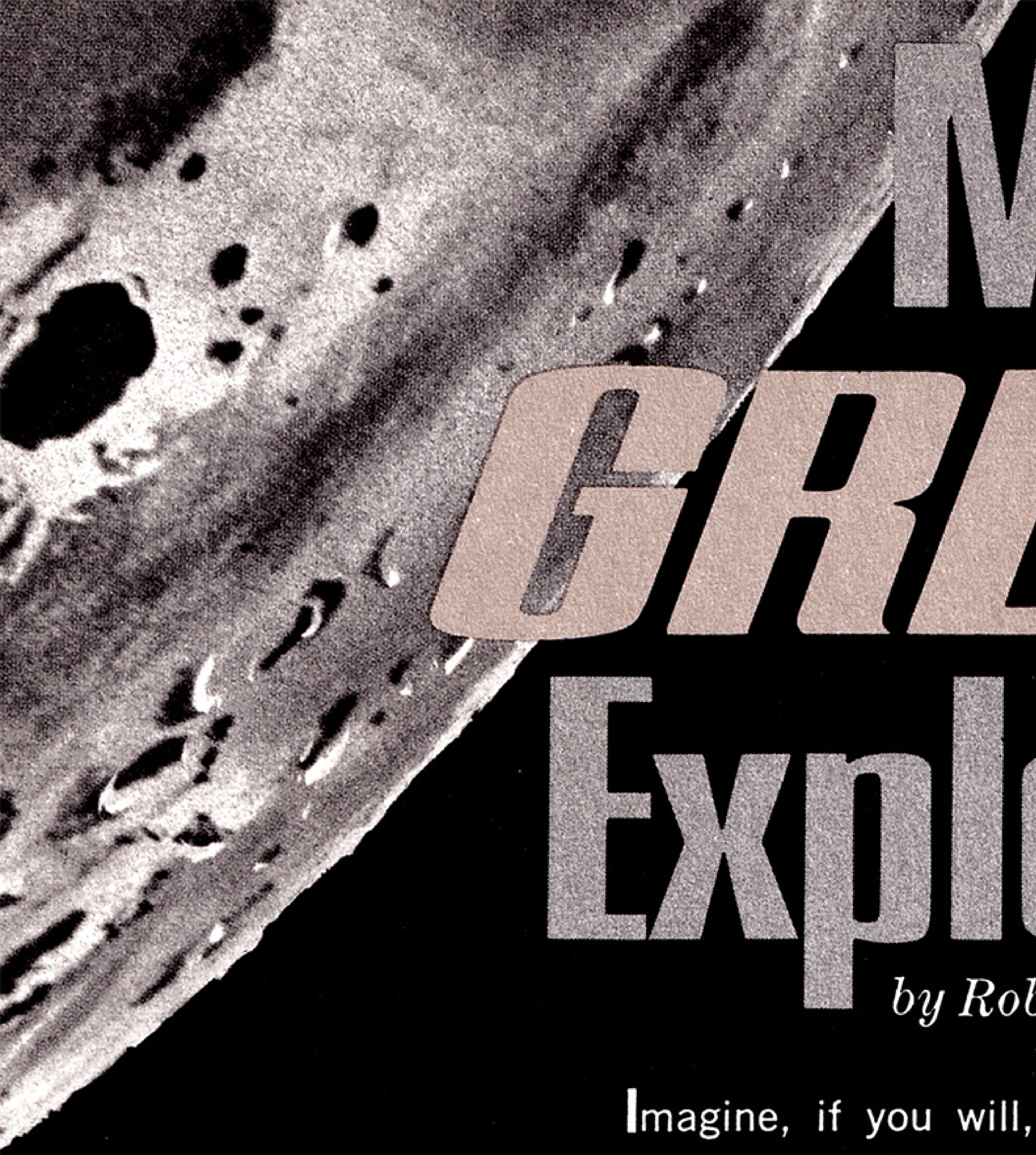
On Flushing Bay was the Glenn H. Curtiss Airport, which the Curtiss company had developed out of a former amusement park in 1929 with the aim of serving wealthy Long Island sportsmen. This field was commonly known as North Beach. With the new Triborough Bridge being built over the East River, it would be within a 20-minute taxi run of Grand Central Station. LaGuardia went after North Beach. He got it in 1937 and converted it into the New York Municipal Airport (No. 2).

LaGuardia objected strenuously to having his name attached to the airport, but at last acceded.

The final stages of the project were a race against time. The New York World's Fair was to be opened in the Spring of 1939. LaGuardia hoped to open the airport at the same time. This didn't work out. The airport was not dedicated until October, 1939.

Another blow to Floyd Bennett Field had been Pan American's decision that it wouldn't do for a Clipper base for the transatlantic service soon to begin. Jamaica Bay had too irregular a bottom. Instead Pan American developed its own base at Port Washington on Long Island's north shore. This was still 25 miles out of New York and LaGuardia—installing seaplane facilities—hoped to have the Clipper terminal transferred to LaGuardia Field. In this he succeeded, as well as in winning the airmail terminal from Newark. With the opening of LaGuardia, Floyd Bennett Field was turned over to the Navy as a U. S. Naval Air Station.

LaGuardia Field had been open only two years when New York initiated action for a far bigger airport on the northeast borders of Jamaica Bay. New York International Airport—Idlewild—cost more than $200 million and was opened on July 1, 1948. ■ ■ ■



Man's GREATEST Exploration

by Robert R. Gilruth, Director, Manned Spacecraft Center, NASA

Imagine, if you will, that you are preparing to start on a 240,000-mile road journey never before traveled.

Your automobile will pass over craggy mountains and by whirling rivers and dark lakes yet unseen by human eyes. To make this road trip, you must simultaneously plot your road map as you press your foot to the accelerator. Since no one has passed this way before, your map constantly is being revised as you move ahead.

In the beginning, you have no fixed mileage scale. National interstate highways—even dirt farm roads—have yet to be constructed. At each intersection five different routes usually appear as likely paths to take. But a wealth of knowledge is readily available for selecting the route, for your journey is part of an integrated program.

Ahead of your automobile are unmanned vehicles traveling toward your future destination and gathering data essential to the success of your journey. Man-driven vehicles similar to your own are traveling part of your route. They provide you with valuable insight on the best judgments to make.

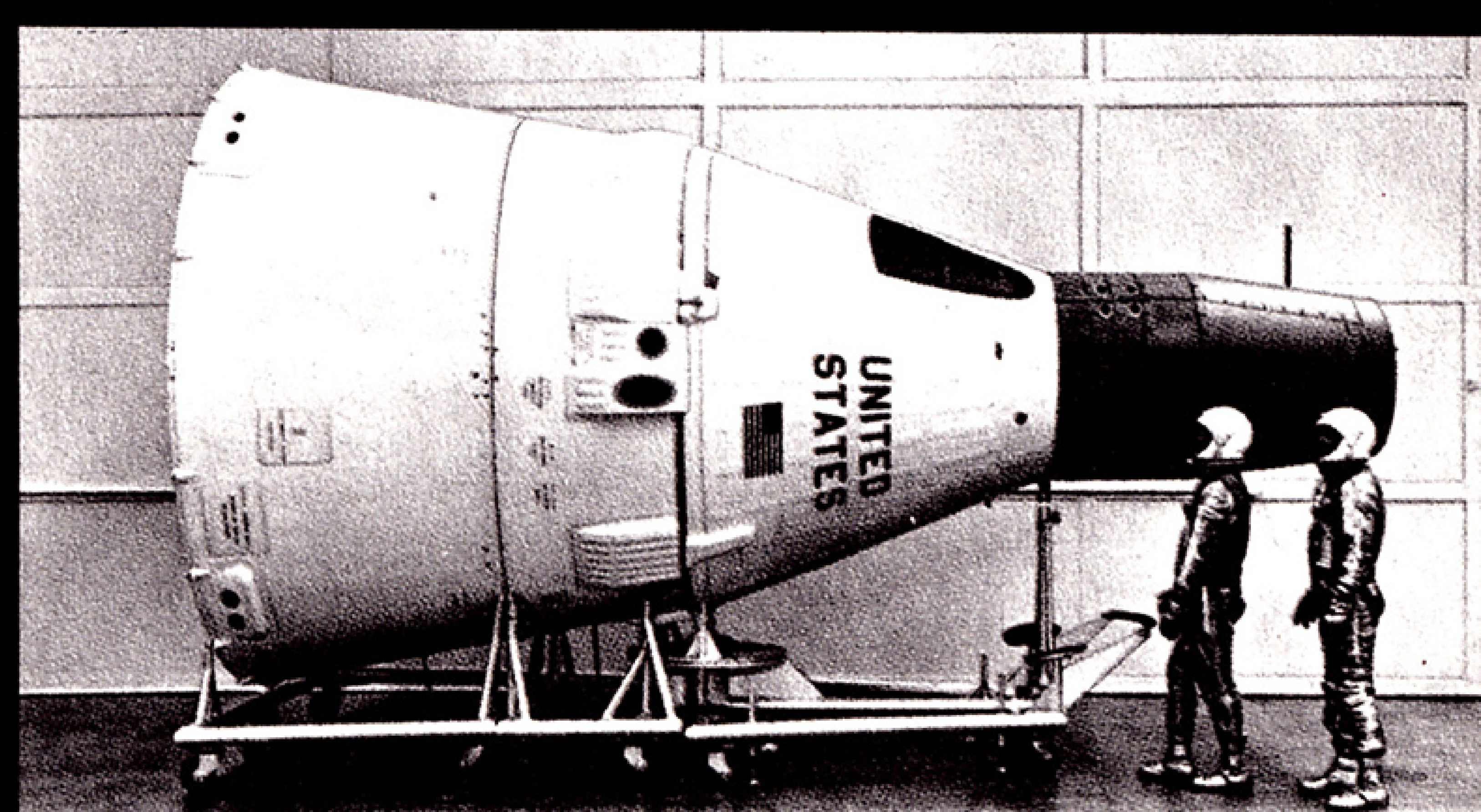
More than 300,000 engineers and scientists, drawn from the finest talent in government and industry, realize the urgency of your travel and work at your side to see that your final destination is reached. The contributions of these dedicated men can never be overestimated. Some integral mechanisms required underneath the hood of your automobile have not yet been invented. But because of their dedication and skill, the engine, the steering device, and even the air-conditioning unit of your automobile can be expected to operate with 99.99 per cent reliability to ensure the fulfillment of your travel.

This mythical illustration underscores, to a degree, the profound complexities involved in Project Apollo. Man's journey to the moon is indeed a journey without precedent. Our endeavor to place him on the lunar surface and safely return him to earth does represent the most ambitious and greatest single exploration in the history of mankind. It is an exploration in which many decisions must be made without the assistance of the conventional road map.

For example, our Agency chose the lunar-orbit-rendezvous approach. This presented several promising routes at an intersection on our road to the moon.

The three proposed Apollo modes finally considered in detail included: the direct-flight mode using the Nova launch vehicle; the earth-orbit-rendezvous mode, requiring separate Saturn launches of a tanker and a manned spacecraft; and the lunar-orbit-rendezvous mode, requiring Saturn launch of the manned spacecraft with lunar excursion module.

Each offered certain distinct advantages. In arriving at a technical determination, critical evaluation was made by measuring the three modes against carefully selected performance criteria.



BIG STEPS *in space program will be two-man Gemini flights, rendezvous practice.*

The unprecedented goals of "more than 300,000 of our finest engineers and scientists" are examined in this article by our man-on-the-moon boss. Their colossal objective: land two Americans on the moon between 1967 and 1970 and then return them safely to earth.

APOLLO CAPSULE *will carry three Americans to moon vicinity, later return them to earth. Dr. Robert Gilruth, Director of Manned Spacecraft Center operated by National Aeronautics and Space Administration at Houston, and President Kennedy are shown examining capsule model. The author, 49, earned his Master of Science Degree in Engineering at the University of Minnesota. He has won international recognition as an authority on stability and handling qualities of aircraft, and research on high-speed flight, high-temperature structures, and space flight. As director of the Mercury, Gemini, and Apollo projects, he is one of the nation's top leaders in manned space flight. A boating enthusiast, Gilruth invented this country's first successful hydrofoil system. It enables boats to be operated in heretofore unprecedented conditions of high speed and rough water.*

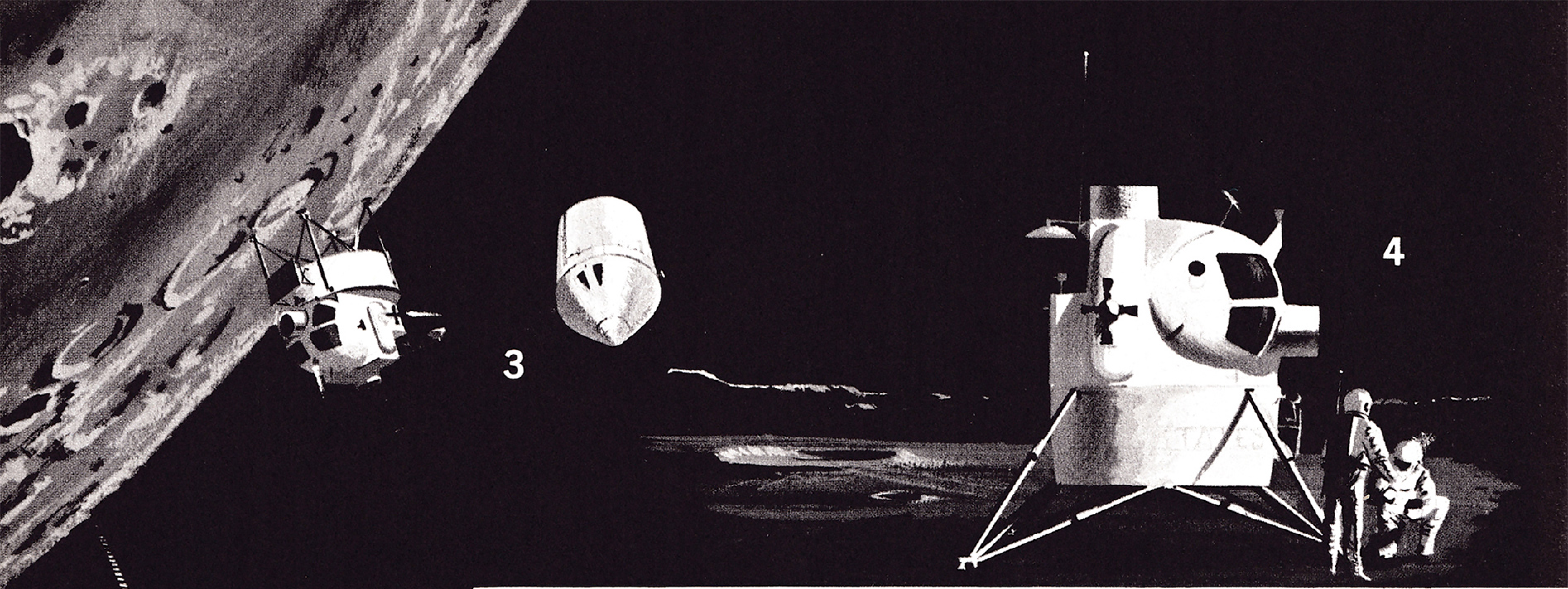
- Consideration was given to the number of men to be placed on the moon, the length of their stay, and the scope and extent of possible lunar-surface operations.
- The guidance accuracy of each of the three modes was compared.
- Communications and tracking requirements were analyzed.
- The development complexity of each of the modes was weighed.
- A major selection criterion was the probability of mission success and mission safety.
- And, of course, the overall mission schedule, both for systems development and operation, was a major consideration.

As these factors were considered in composite, the lunar-orbit-rendezvous mode afforded the greatest potential advantages. Significantly, it would appear that the LOR could conclude a lunar landing and return some months earlier than either the EOR or direct flight.

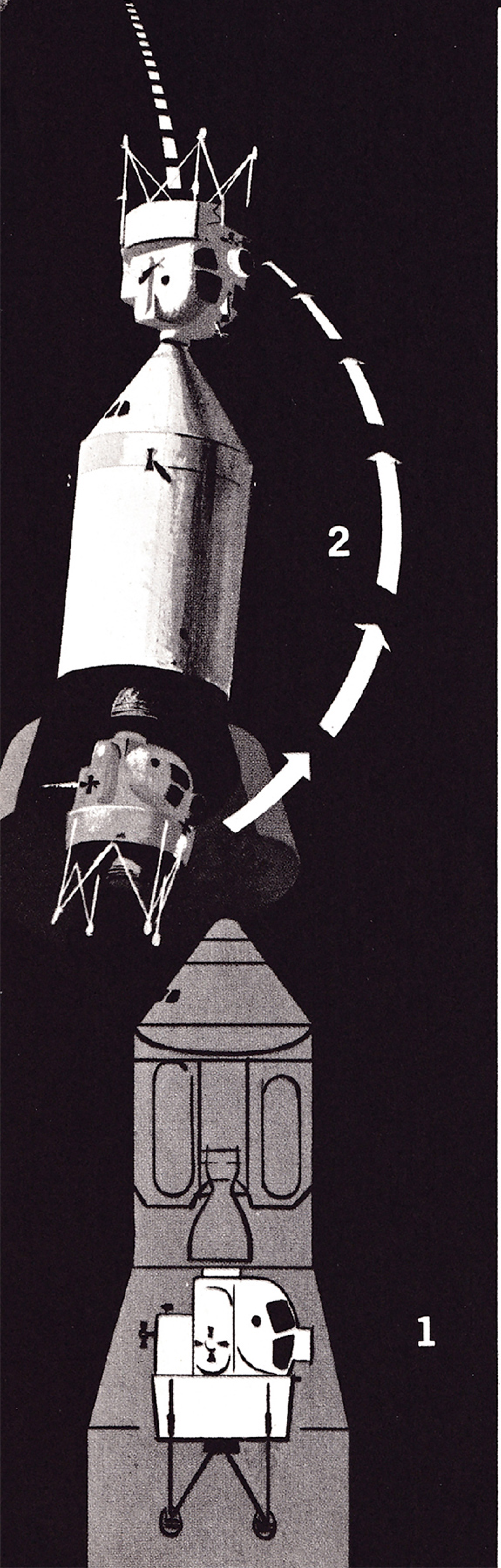
This decision represented the advanced thinking of leading experts in the field—key personnel from NASA's Office of Manned Space Flight, our own Manned Spacecraft Center, the Marshall Space Flight Center (which has responsibility for development of the Saturn launch vehicle) and from industry.

Similar decisions lie ahead, since ours is an integrated manned space flight research effort, encompassing our three manned spacecraft programs. It is almost a standard rule of thumb now that each Mercury flight brings many changes in our thinking about space. No doubt, this expansion of our own knowledge will continue as our programs stretch farther into two-man Gemini flights, with rendezvous and docking operations, dress rehearsals for landing men on the moon, and into the early Apollo flights.

Our manned spacecraft efforts have widened, and are



TO THE MOON AND BACK: *Present plans call for a three-stage Saturn rocket to launch* Apollo (lower left) *from Cape Canaveral in the '60 s. Three astronauts will be couched in the conical nose section. After the last Saturn stage has dropped away, Grumman's* Lunar Excursion Module (note legs) *will be brought around from its aft position and docked at the nose of the Command Module* (2). *Two astronauts will board the LEM or "moon bug". While in a low moon orbit, the bug will separate from the Com-*



continuing to widen, the pool of scientific data available to us in charting our path to the moon. Project Mercury left the launch pad in September, 1959, with an unmanned flight to reaffirm the reliability of systems concepts. In 1961 we progressed into manned suborbital Mercury-Redstone flights with astronauts Shepard and Grissom, and then last year into manned orbital missions, using the Atlas launch vehicle, with astronauts Glenn, Carpenter and Schirra. Now the advancement to the one-day mission has been made by astronaut Cooper.

Late this year we plan to move into phase two of our manned space flight program with Project Gemini. The Gemini will show a family resemblance to the familiar Mercury spacecraft, but will be more than two times as heavy and will have room for two astronauts sitting side by side. The Gemini will be equipped to remain in orbit for a week or more to thoroughly test the reactions of the astronauts to prolonged weightlessness.

Gemini's other important mission will be to demonstrate the techniques of space rendezvous and the coupling of the spacecraft and an Agena target vehicle while both are in orbit.

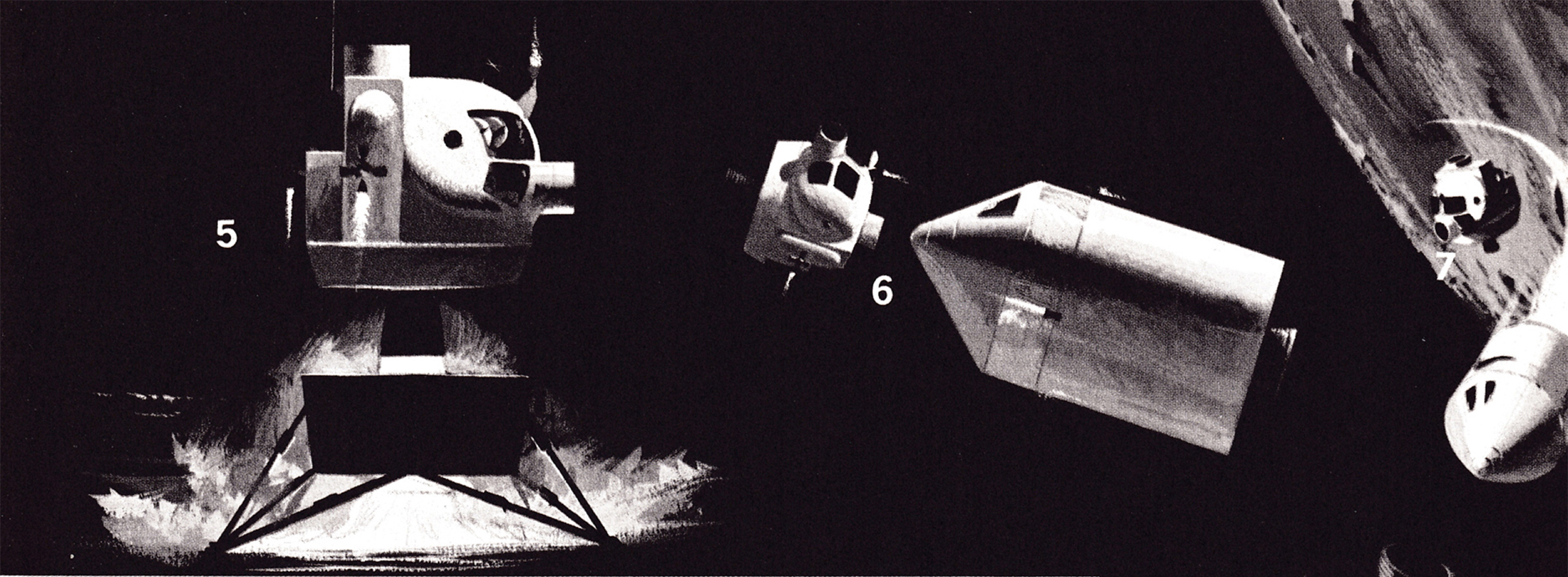
After Gemini, of course, comes Apollo, the three-man spacecraft destined to make the round-trip journey to the moon and back, after we have tested it on several earth orbits, including a two-week mission and a trip around the moon.

Simultaneously with our manned spacecraft endeavors, we are also enhancing our capabilities for dealing with an alien space environment and manned lunar landing through sending unmanned spacecraft to the moon's surface. The necessity for acquiring this advance knowledge through unmanned instrumentation and study coincides with the urgency of moving ahead with our manned space programs.

Ranger, a rough-landing lunar probe, is designed to take high-resolution TV pictures of the lunar surface during its approach to the moon and, after impact, will make seismograph studies to record meteorite strikes against the lunar surface.

Later, Projects Surveyor and Prospector will make controlled or "soft" landings on the lunar surface to give us much more definitive data about the moon.

Our many-faceted, yet integrated, manned space flight program unquestionably



mand Module and descend to the moon's surface. The two astronauts will explore the moon for one to seven days. Then they'll blast off from the moon (5), *leaving the landing-launching stage behind, and dock with the moon-orbiting Command Module. The two astronauts will join the single astronaut inside this module, cast off the bug, and head for earth. Before earth re-entry, the service module will be dropped away* (8). *After the three-man nose cone has slowed down, parachutes will lower it to land.*

represents a magnificent wave of challenge to our management groups within the National Aeronautics and Space Administration. However, as we surge into the frontiers of space, the imaginations and inventive minds of the nation's growing aerospace industries are tested as well.

The manned lunar landing program involves the greatest single engineering effort ever made by our government-industry team. In size and scope, it dwarfs the most spectacular programs of the past.

Today, more than 5000 of the nation's industries are directly involved in our efforts to place a man on the moon. To make good our pledge of a successful lunar landing and return, more than \$3.5 million is spent in this behalf daily.

We can succeed in the management area of this tremendous undertaking only if both industry and government clearly understand that what is needed is a joint government-industry effort in the best sense of the expression. We must develop a real team spirit and build up contractor-government teams in every phase of Apollo development. To fulfill our obligation to the American public, systems management is the key.

However, the American public holds the greatest decision of all. In the final analysis, the determination as to whether or not we achieve our lunar objectives within this decade rests with our fellow citizens. Because of this fact, no effort should be spared to enlist the understanding and support of every single American. The prestige of our nation rides with Apollo.

The case for man's flight to the moon was most forcefully described by President Kennedy when he stated: "The exploration of space will go ahead, whether we join in it or not, and it is one of the great adventures of all time, and no nation which expects to be the leader of other nations can expect to stay behind in this race for space."

Apathy in men's minds can be an insurmountable impasse to progress. Christopher Columbus spent 18 futile years in the royal courts of Genoa, Portugal, England and, finally, Spain before he persuaded King Ferdinand and Queen Isabella to support his enterprise. You can visualize the advanced "state-of-the-art" that our programs might now have achieved if Dr. Robert Goddard's early experiments had secured

(Illustration by Edward Hanke for BUSINESS WEEK.)

the early support of the American public.

Some aspects of our man-in-space program definitely warrant the fullest understanding of the American public. Certainly an answer to why we should have a man in space at all is one of them.

It should be emphasized here that the man in space is more than a test pilot and much more than a "backup of redundant systems" in the spacecraft. Man's most important job in space is to test, to observe, to experiment, to explore and to seek out new knowledge. These are tasks that are singularly unique to man's capabilities. We intend to man Apollo on the earliest possible flights. Men will be aboard during the first earth-orbit missions, to be followed by missions of increasing difficulty.

No doubt, the manner in which we plan to land men on the moon and return to earth rouses the curiosity of many citizens. The American public should be privileged to know some of the particulars concerning our operational plans for the lunar landing missions. Let me recount briefly our Apollo lunar landing flight plans:

The complete Apollo spacecraft consists of three major elements: the Command, Service and Lunar Excursion Modules. In the lunar-orbit-rendezvous method, the complete Apollo spacecraft is lifted by the 280-ft, three-stage advanced Saturn launch vehicle with 7.5 million lb of thrust from five F-1 engines in the first stage. Following separation of the second stage, the Apollo, plus the third stage of the Saturn, is placed into earth orbit before committing the spacecraft on its translunar mission. When the mission is committed, the third stage of the Saturn burns for a second time, providing the added velocity necessary to place the Apollo on its earth-to-moon trajectory.

After the third stage of the Saturn is separated from the spacecraft, the Command and Service Modules will be reoriented to mate the Lunar Excursion Module in a nose-to-nose manner. This can be done either by flying the Command Module to its reoriented position or by transferring the LEM by mechanical means. Further study will determine which alternative is better. Course corrections are made to the Apollo spacecraft with information received from the onboard guidance system in the Command Module.

About 72 hours later, the Apollo spacecraft will deboost into lunar orbit approximately 100 miles away from the lunar surface. Two of the three astronauts will then transfer to the LEM through the connection point between the two vehicles. The LEM will then be separated from the Command and Service Modules which will remain in lunar orbit.

The main engine of the LEM's landing stage will decelerate the vehicle. Then, through a carefully blended combination of manual control and automatic system operation, the LEM will be lowered nearly to the surface, will hover and, if necessary, move laterally so that the crew can select the touchdown point. At any time during descent, the crew can return to the mother ship.

Following an exploratory period of from one to seven days, the LEM crew will fire the launching engine at a precisely determined instant while the mother ship is within line of sight. The LEM will enter a transfer ellipse calculated to rendezvous with the mother ship after traveling part of the way around the moon. The docking of the mother ship and the LEM will be controlled by the crew of the LEM.

After docking, the crew of the LEM will transfer back into the Command Module, and the LEM probably will be left in lunar orbit to save weight on the return trip. When the Command and Service Modules have been thoroughly checked out and all calculations confirmed, the Apollo spacecraft will be fired into its return trajectory. Following course corrections and just before entering the earth's atmosphere, the Service Module will be jettisoned and the Command Module will be oriented for re-entry. At an altitude of approximately 50,000 ft, a drogue parachute will deploy to stabilize the vehicle. This will be followed shortly by the main parachute system, which will gently lower the Command Module to earth—probably on land rather than at sea.

When our first lunar explorers are recovered, an eager nation will receive them with the same warmth that has attended the return of our Mercury astronauts. Citizens of all ages will expectantly await their accounts, for these will be men who will have seen with their own eyes the moon's dark, circular craters 100 miles wide. They will have looked up at the mountainous lunar walls 20,000 ft high. They will tell of adventures that men dreamed about for centuries.

It will be a grateful nation, for the space research and development with which this journey is associated will pay dividends in almost every part of the American economy. New consumer products will be originated. New methods for the diagnosis and treatment of diseases will be developed. And new fields of employment will be created.

As the motorcades, the press interviews, and the fan mail for our lunar explorers subside, we will then be looking far ahead for the new challenges . . . and plotting our maps for the celestial frontiers beyond.

SYSTEMS MANAGEMENT

by Gerard M. Maurer, Grumman Program Management

- ☑ born of complexity
- ☑ contractor: prime and subs
- ☑ the problem of interface
- ☑ its solution: integration
- ☑ the airframe company as integrator

Not since the days of small, simple engines and seat-of-the-pants flying has any manufacturer had the facilities and capability to produce an entire airplane single-handedly.

Until the emergence of complex electronic systems, powerplant manufacturers were the heaviest contributors to the airframe manufacturer, who integrated the powerplant and the airframe. Later, the airframe prime became dependent on the electronics industry, as well, for components and subsystems.

Today, the pie is cut into a multitude of slices. In a manned space flight program, for example, a dozen functional subsystems from many sources must be integrated in order to produce the spacecraft which will perform a given mission. These include guidance, attitude control, communications, tracking telemetry, life support, environmental control, re-entry protection, and recovery systems. All of these subsystems must be compatibly accommodated in an overall structure.

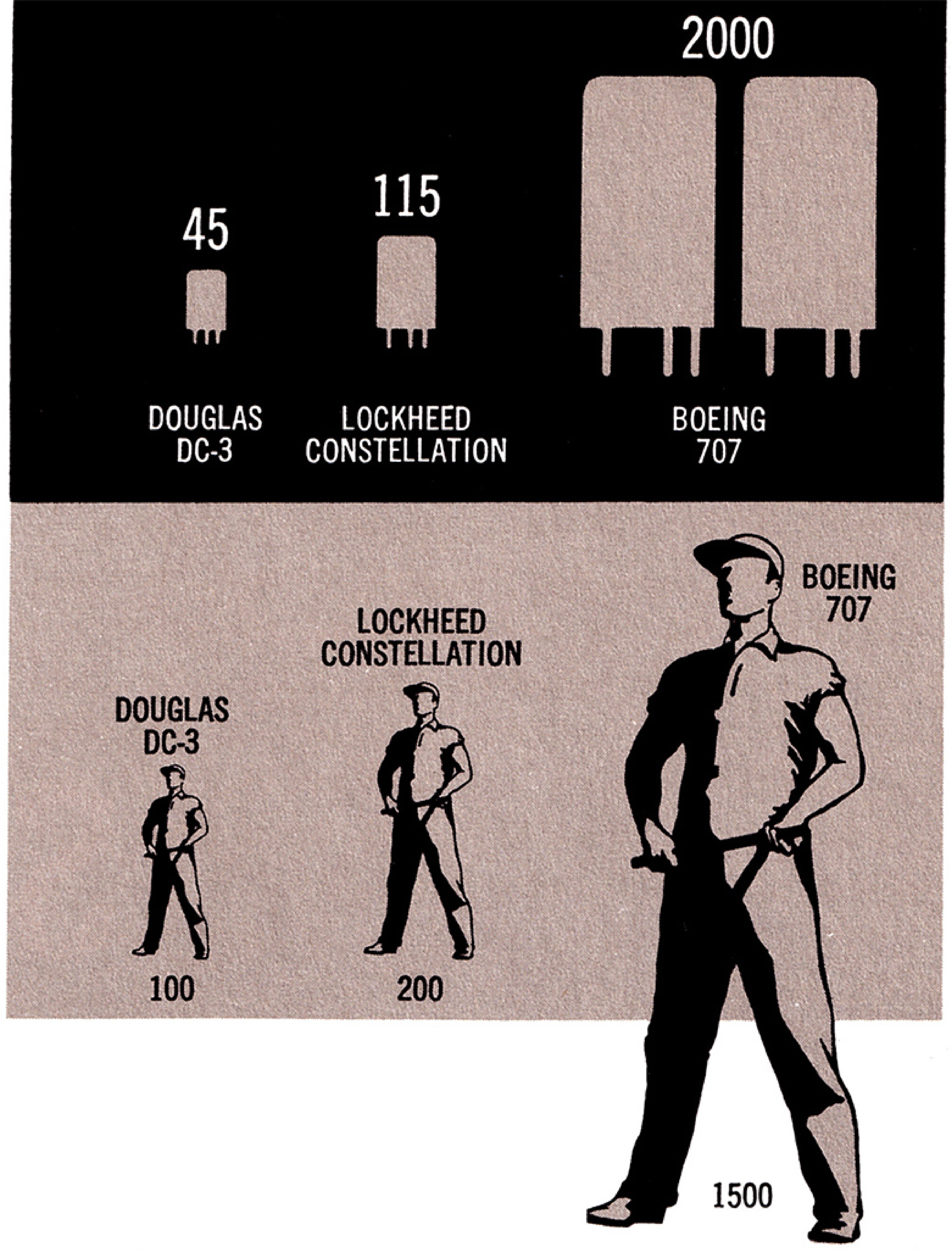
But one needn't look to so exotic a field as space flight to document the increasingly obvious fact that today's prime manufacturer can no longer maintain the in-house capabilities to produce more than a few subsystems if they are widely divergent. Today, his most important task is to develop complete integration capability for peak performance of the total article. As air travelers, most of us are frequently reminded of the growing complexity of that familiar workhorse, the airliner. A dramatic example is provided by S. L. Higginbottom, Trans World Airlines Assistant Vice President, whose statistics are the basis for the accompanying graphs *(pages 18 & 19)*. "Aircraft," Higginbottom says, "have progressively grown in overall complexity from the DC-3 days, with the increase being more nearly quadratic than linear on the jets."

But even the electronic complexity of the jetliner is dwarfed by that of a military airplane roughly one-third the Boeing 707's size—the Navy's E-2A Hawkeye. For ground control of as many as 250 simultaneous flights of jetliners and other aircraft between Norfolk, Va., and Boston, Mass., the Federal Aviation Agency's Air Traffic Control Center at Idlewild Airport has some 100 persons using dozens of radar consoles and other electronic devices. But the Navy's Hawkeye—with two pilots and three men at three airborne radarscopes—has the capability to handle all the air traffic described above. Almost all of the collection, evaluation, and remembering of facts is done automatically—with lightning speed and flawless accuracy—by one of the most compact and advanced electronic early warning and intercept control systems ever produced.

This computerized sky sentry automatically searches out, identifies, and keeps constant track of all aircraft and surface ships within its radar range. The system also controls friendly aircraft, directing these to intercepts with enemy weapons systems. This system, called ATDS (Airborne Tactical Data System), computes immediately and automatically which are the best friendly weapons systems to do the particular jobs by providing facts about armament, position, performance, fuel reserve, etc. Hawkeye must keep this information updated, minute by minute, and it must know exactly where it and other weapons systems are, and where friendly headquarters is.

Hawkeye must keep fleet headquarters constantly and automatically informed, relaying to similar computerized equipment data which is displayed in the Combat Information Center—supplying the tactical information and air control which enables the task force commander to employ his offensive surface and air units most effectively.

In addition to these capabilities, the system's 10,000 pounds of electronic equipment had to be compact enough to fit aboard a carrier-based aircraft of limited size, rugged and reliable enough to take the shock of catapult launchings and arresting hook landings.



NUMBER *of electronic tubes and semiconductors in airliners has risen from 45 on the DC-3, through 115 on 1957 Constellations, to nearly 2000 on today's jetliners. Similar evidence of skyrocketing complexity of aircraft is the fact that to qualify an average mechanic to completely handle the electronics system took about 100 man-hours of training for the DC-3, more than 200 man-hours for the Constellation, and 1500 for the jetliner.*

The Hawkeye with its ATDS system poses the question: could such a system be assembled using airframe sections and subsystems that had not been designed from inception to fit together mechanically and electronically and to operate compatibly?

Obviously, the answer is no. Each part affects every other part and therefore must be designed or carefully modified to reflect the influence of all the other parts. This is the problem of integration. It dictates the need for complete understanding of all the disciplines involved, flight environment, and ground handling conditions to be able to peak the performance of all the parts and make them operate compatibly in the overall system under the predicted operating conditions.

As weapons systems became more complex, the "systems management" concept gradually evolved among aerospace companies. More and more complexity meant a greater percentage of the work, often of an electronic nature, had to be subcontracted. It became a specialty

job in itself to manage the development, design and production of multifarious subsystems or parts.

But, even though an airframe manufacturer is not staffed for the detail design and production of many of the individual parts of subsystems, it is necessary for the systems manager to staff his organization with engineers capable of thoroughly understanding the design of every part that goes into the aircraft system. How else could the systems manager monitor and evaluate the work being performed by outside manufacturers for him? These experts must know how a system can be designed, tested, and produced; the state of the art in many fields as diverse as radar and propulsion; and what items and subsystems various firms in each field are capable of producing.

Grumman's Hawkeye program is a good example of the systems management role in the production of today's advanced aerospace systems. Perhaps no other aircraft program in the American arsenal has ever employed, to a higher degree, this technique of integrating complex electronics into an airframe.

To satisfy the requirements initially specified by the U. S. Navy, the preliminary design phase of the integration of Hawkeye's many electronic subsystems was accomplished by Grumman engineers in consultation with Navy technical and laboratory personnel, scientists, and vendor engineers. These meetings gave birth to the "systems concept." Next, the group, working closely with the airplane designers, specified the electronic and physical criteria for the new designs. Grumman then determined what production facilities were available and selected subcontractors.

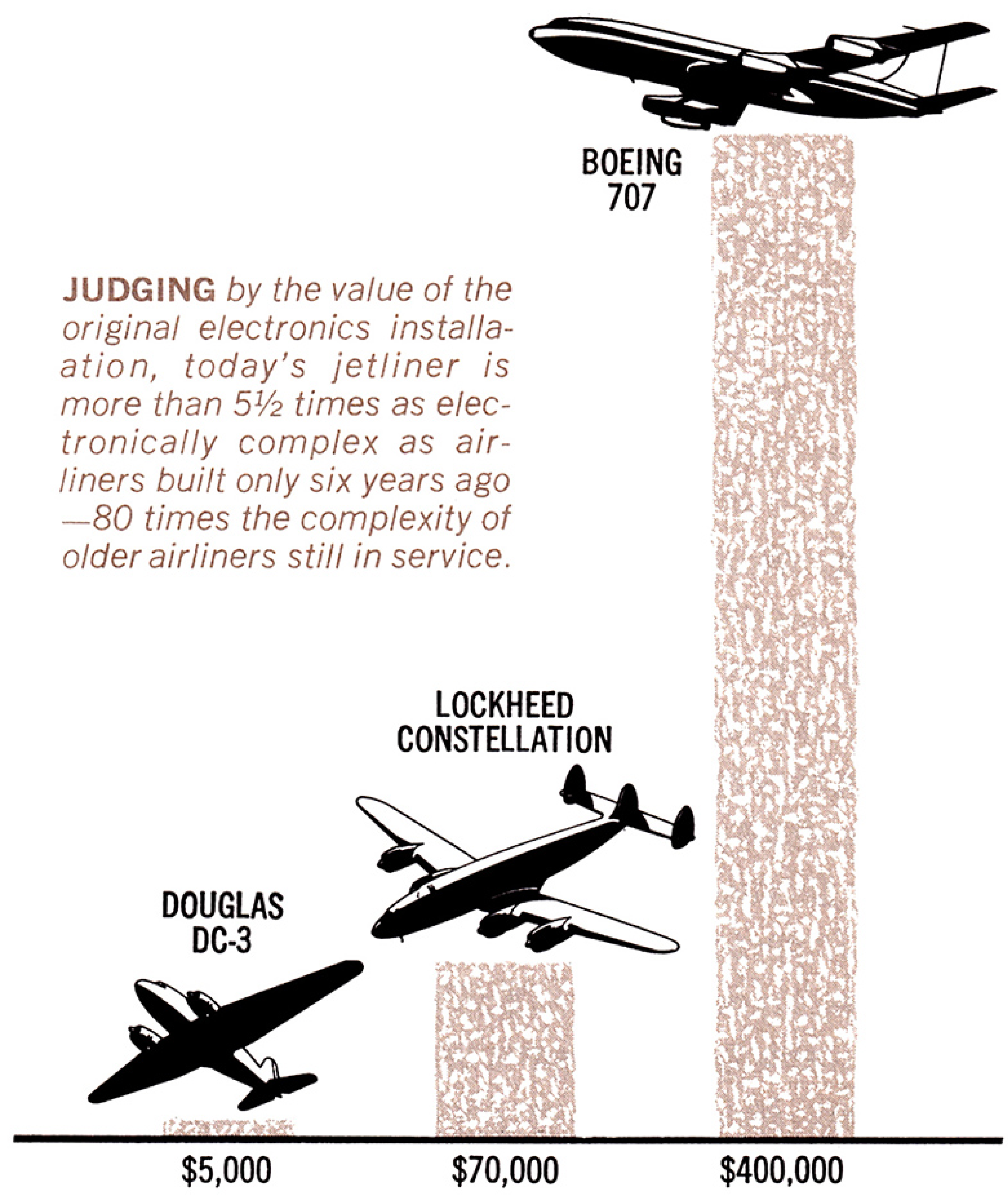
The time schedule for the development of this Airborne Early Warning (AEW) system precluded the use of the traditional "series" development effort. This type of effort progresses from the breadboard stage to the service test model and then to preproduction model. Preproduction testing is accomplished before the first production hardware is accepted for use in the aircraft, at which point avionic flight development begins.

In the case of the E-2A Hawkeye system, an engineering judgment was made to start a parallel development effort, allowing simultaneous testing and laboratory and flight development, in order to meet a tight Navy schedule which dovetailed with other Navy systems under development, such as the F4H and the Naval Tactical Data System.

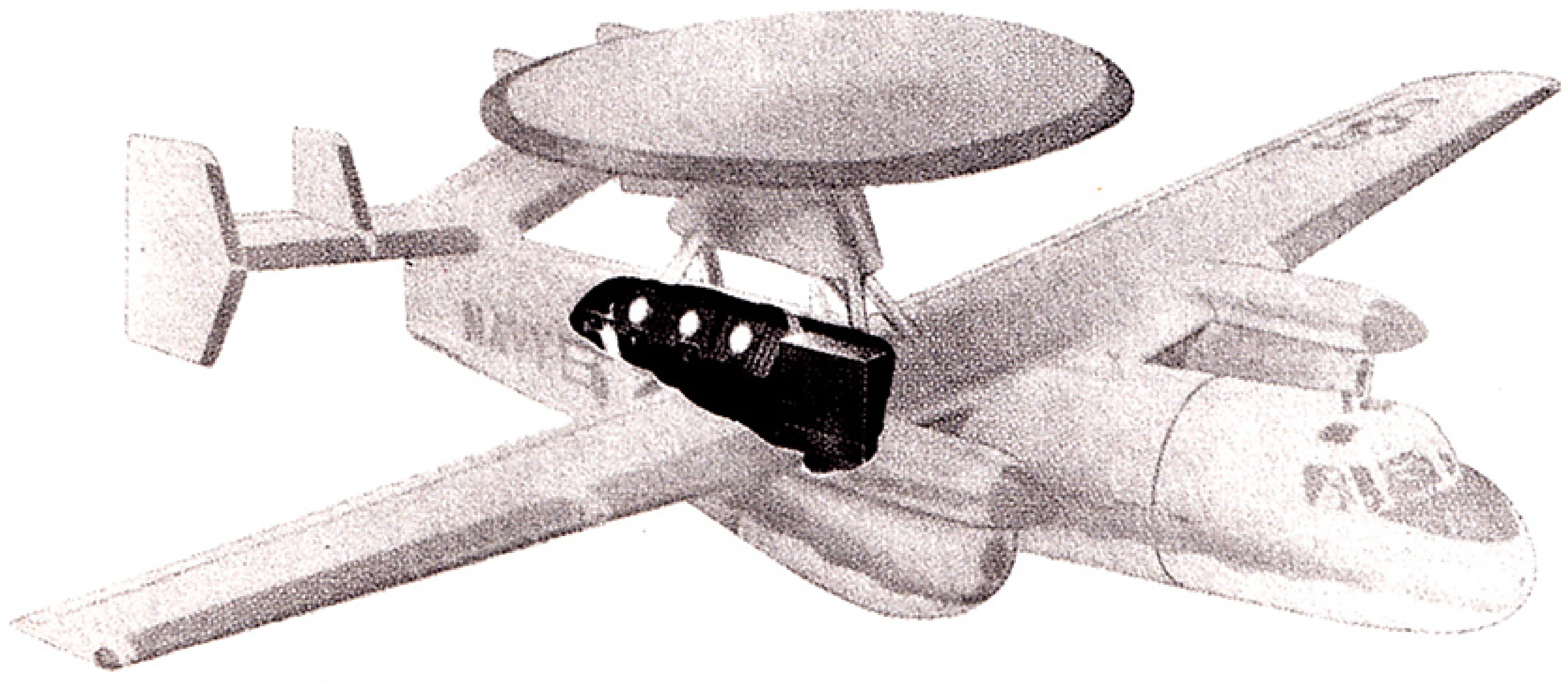
The operational phase of overall integration began when a set of prototype production equipment from all the suppliers was assembled in one place, connected to a power source, and tested. Here is where the crucial results of "interface" management, a major integration task of the prime contractor, were proven. Each part, made by different manufacturers often thousands of miles apart, must work or be made to work together compatibly without downgrading the peaked performance of every other part.

In the case of the Hawkeye, Dalmo Victor in the San Francisco area was picked as the specialty company best qualified to produce the rotodome. This giant rotodome contains an advanced radar antenna design that marks a step forward in the state of the art. Overall weapons system integration required, in addition to electronic compatibility, that it be packaged in an aerodynamic shape which permits it to bear its own weight in flight. This was done.

The heart of the system is a high resolution radar and its associated computer-detector, made by General Electric in Utica, N. Y. The power and form of the energy produced by the radar, which is beamed out by the antenna array in the rotodome, was specially created for this system and also represents an advance in the state of the art of target illumination. The receiver portion of the radar is designed specifically to handle the unique form of the reflected energy from the targets as received by the antenna. The computer-detector assimilates this signal into meaningful form that eliminates sea clutter, computes target height, and weeds out false targets.



JUDGING *by the value of the original electronics installation, today's jetliner is more than 5½ times as electronically complex as airliners built only six years ago —80 times the complexity of older airliners still in service.*



AS SYSTEMS MANAGER, *Grumman integrated equipment produced by Litton Systems, Dalmo Victor, General Electric and other companies into the Hawkeye airframe.*

Litton Systems' specialized knowledge in digital computer techniques was called upon to produce the airborne computer-indicator. This is the electronic brain and memory system which constantly records, analyzes, and translates what the airborne radar and computer-detector have processed and displays this information for the operator. The Los Angeles firm designed the indicator's memory drum to handle 750,000 separate bits of information and packaged the whole to be compatible with the weight distribution, operation, and other special requirements of the compact E-2A fuselage.

To start the complete operational phase of the integration of these advanced subsystems, a full-scale physical test facility, called the "Copper Queen," was set up in Utica. Its electronic and dimensional environment exactly duplicates the fuselage midsection of the Hawkeye.

This is where the total AEW electronic system was tested as a preliminary to final integration of the whole E-2A system at Grumman.

In parallel with these efforts, the ground phase of the overall electronic system integration began with the checking out of individual subsystems and components, connecting them together one by one until the complete system could be operated as a unit. This part of the integration process uncovered incompatibility and reliability problems. Each was corrected until a reasonably reliable peaked operational system was evolved. This work was done in Grumman's $5 million Electronic Systems Center in Bethpage, New York. The Center, built at Grumman expense, reflects the Company's conviction that the full application of integration techniques in facilities tailored for this type of work is the key to producing the most efficient aerospace systems. The Center is another reminder of the passing of that era when an aircraft company could excel merely by building superior airframes that were tough, swift, and reliable—an era when the government bought the electronics and accessories and the airframe company just put them in.

In its test labs, Grumman creates as much of the actual operational environment as possible. An "Iron Monster," for example, tests Hawkeye's flight control system with almost total duplication of actual flight, saving much flight test time.

Simultaneous with the checkout and integration of the electronic subsystems, the aircraft itself was developed, underwent rigorous testing, and was proved out in flight tests.

Integration of the electronic system with the airplane system was started before either had been fully proven. All unpredictable effects of one system on the other became evident as each system was integrated into a unit completely compatible in the flight and ground handling environment. Many hours on the ground and in flight were required to find and correct faults generated by incompatibilities in order to peak the overall system in compliance with the contractual requirements for service operations.

The Hawkeye is a classic example of why an airframe manufacturer with an electronic system integration staff and facility must assume the role of systems manager.

The systems management organization must, by experience, understand the flight phenomena and environment as well as electronic design and packaging. The systems manager must have the authority to compel recognition of the effects of the flight environment in terms readily understood by the electronics designers. For, aside from the problem of establishing interfaces between equipments so that they will perform as a system, an even more formidable problem exists in marrying the basic electronic system to the airframe.

For instance, every airframe design is sufficiently different, one from another, to require extensive integration work if the electronic system were to be taken in its entirety from one and installed in another. Considerable electronics redesign probably would be required before the system would give peaked performance in an airplane design other than the one with which it was originally integrated.

Rotodome antenna performance, for example, was degraded when the antenna was first flight tested on the Hawkeye, despite favorable results in the purity of the laboratory. Grumman discovered during flight testing

that radio frequency energy transmitted and received by the antenna was being distorted by reflections from the E-2A's airframe.

Data on these aberrations was organized and presented to the antenna manufacturer, who redesigned the antenna accordingly.

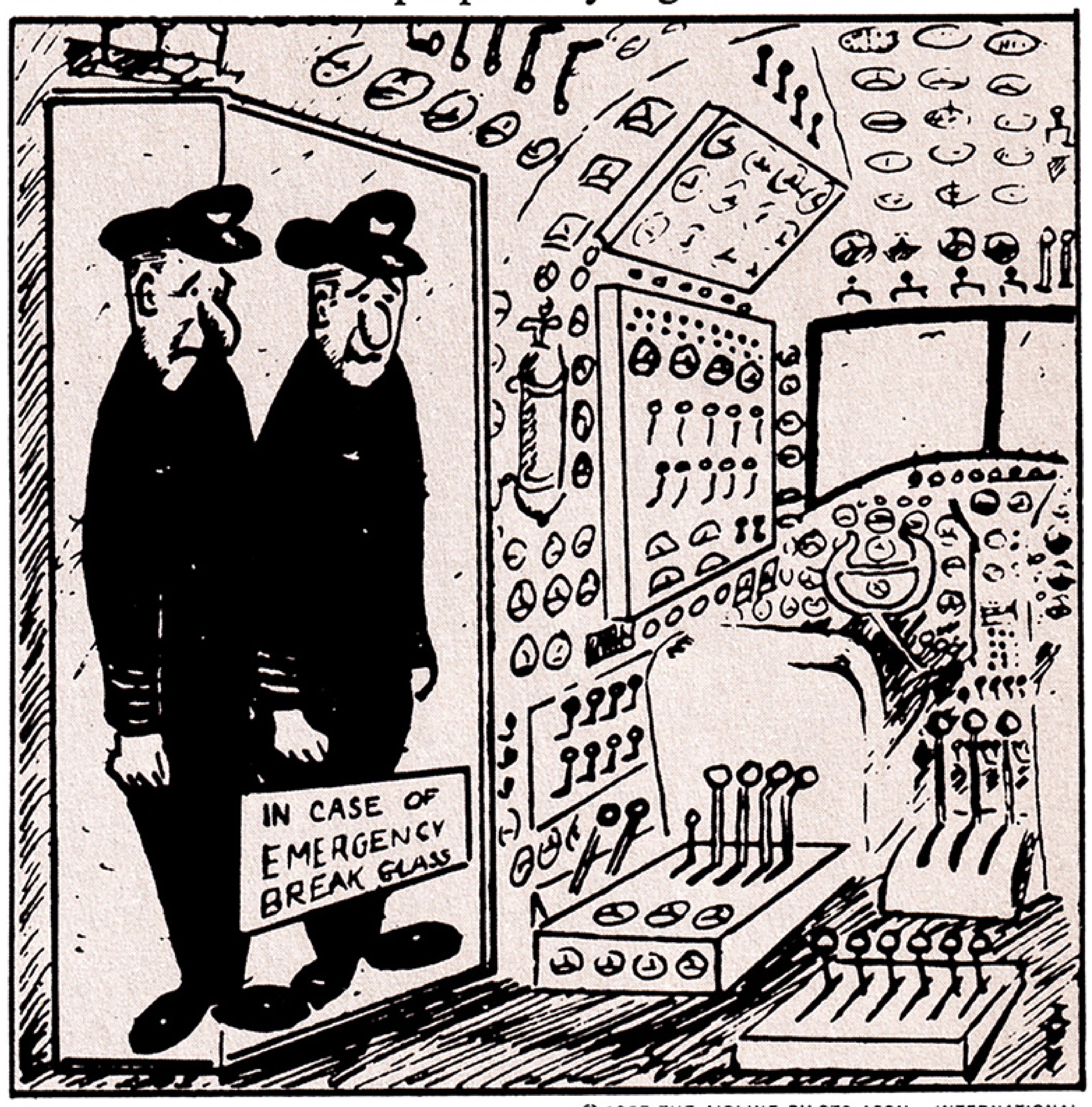
The aviation industry has acquired flight environment experience that has been paid for with lives and long hours of hard work involving the most advanced scientific knowledge available, and much trial and error. This experience is dynamic in that something new is added every day, and much of the unknown that is learned is discovered in flight. No earthbound laboratory can truly simulate the actual flight conditions in their entirety. No piece of mechanical or electronic equipment is going to perform reliably in the flight environment if the pertinent influences of this environment are not accommodated in the design. Only experienced people daily engaged in analyzing the continuing flow of flight data, and in designing advanced flight machines, can really know what is to be known about the true flight environment. The airframe manufacturer must anticipate this environment (the gusts and turbulence, once in awhile hitting the ground harder than expected, and other variables) or find himself face to face with a failure he must fix after his oversight causes trouble in the flight environment.

There are fundamental reasons why airframe companies have historically been the prime contractors and systems managers. First and foremost, these are the companies which have struggled with the environment ever since that memorable event at Kitty Hawk. They have built up a mountainous mass of firsthand information on manned flight. With this knowledge, aerospace systems management has evolved into a highly refined art. The know-how to conceive, design, develop, and finally produce an aerospace product cannot be acquired inexpensively overnight. This is not to say overall supervision of a program can't be performed by some element of the aerospace industry other than airframe companies. It is to say that it can't be done as cheaply. It can't be done as precisely on schedule. And it can't be done without consequent loss of reliability and performance.

In this regard, one Navy Admiral has stated:

"Although the production capacities of certain industries can be expanded rapidly, there is one essential element that can't be acquired overnight. That factor is experience. Therefore, the Navy selects its prime contractors and systems integrators from among those companies which, through the years, have produced aircraft and supervised all aspects of production. For the Navy to do otherwise would result in inefficiency and waste the taxpayer's money."

There is one other point to consider. It has already been pointed out that by choosing the best from the specialty companies, such as electronic systems, the end product reaps the benefit in terms of superior performance. One reason airframe companies electronically oriented toward integration rather than manufacture can do this is that the proprietary rights of its electronics

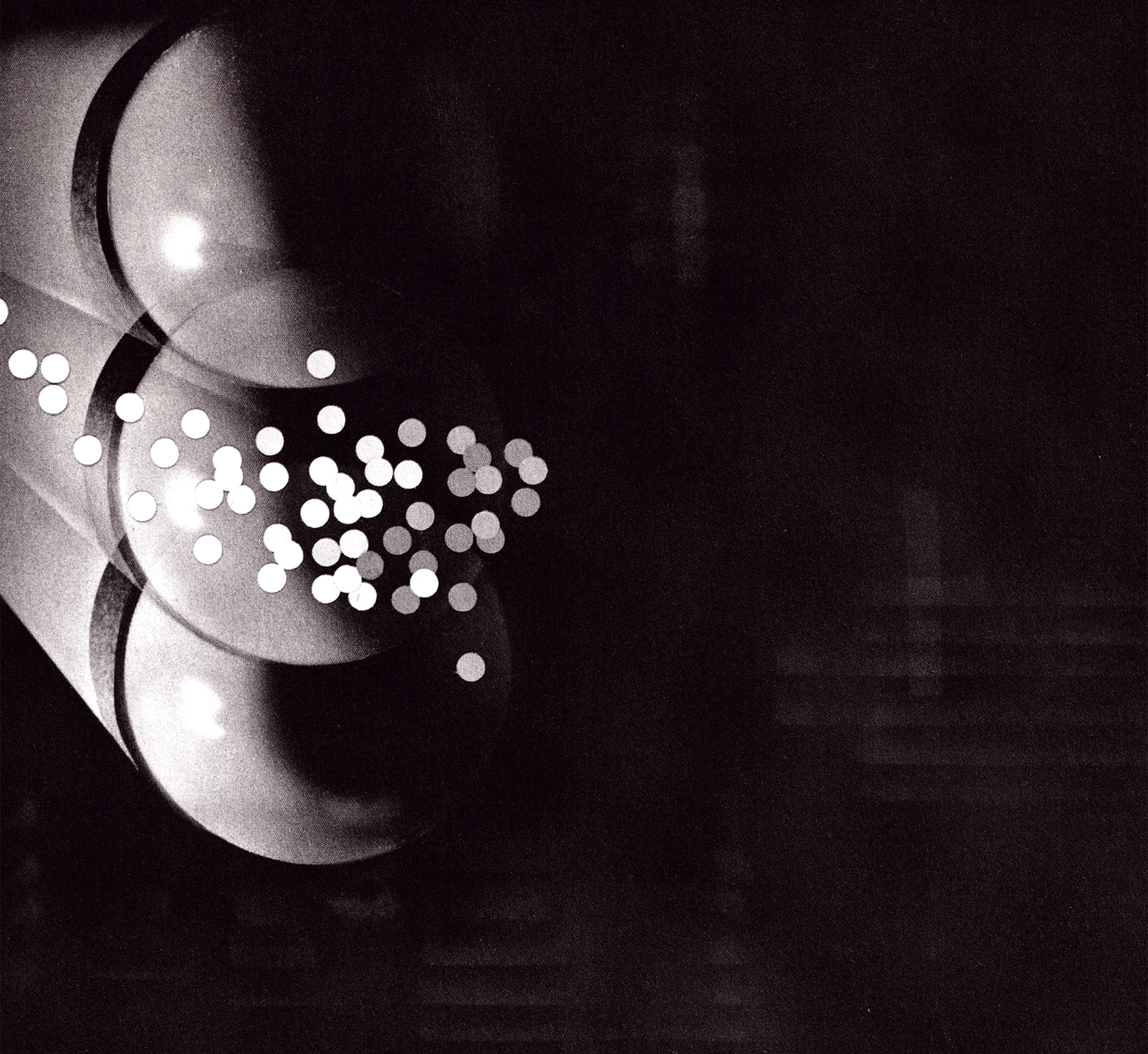


"the growing complexity of that familiar workhorse, the airliner"

subcontractors are not threatened by a competitive company. Electronics companies, in particular, are eager to reveal the capabilities of new designs to such an airframe company. In state-of-the-art breakthroughs, would this eagerness be manifested if the prime contractor were an electronics company? How many conflicts would arise over the monitoring of an electronics company's design by a direct competitor?

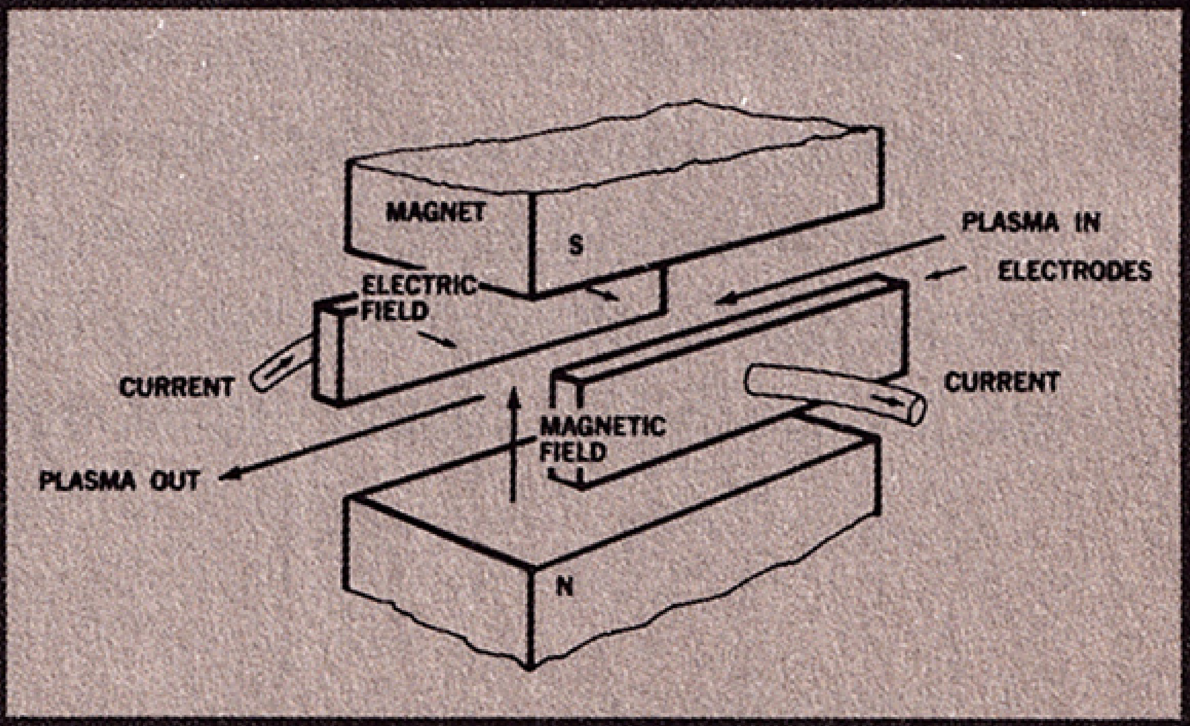
Does the dawning of the space age change all this? Not a bit. In or out of the earth's atmosphere, manned flight employs a vehicle which must be controlled by a human being sustained by an artificially created environment. More than ever before, the vehicles carrying man are called upon to perform with almost fantastic reliability. They must be designed with complete concern for the man inside, from life support systems to human factors considerations.

In short, the skills needed to design, develop, and produce a manned space vehicle are mere extensions of the skills perfected by what was once called the aviation industry.



MAGNETOHYDRODYNAMICS

TONGUE-TWISTING OUTPOST ON THE SPACE FRONTIER



As long in promise as it is in syllables, magnetohydrodynamics is offering us fascinating new systems for space as well as earth use.

But before looking at these, let's define this nonstop word. Magnetohydrodynamics (MHD, for short) is the science of electrically conducting fluids interacting with electric and magnetic fields.

This science is quite similar to plasma physics which, however, deals only with ionized gas and its interaction with electric and magnetic fields. Actually, theories of the two fields overlap and often can be considered equivalent. We'll use the two terms interchangeably.

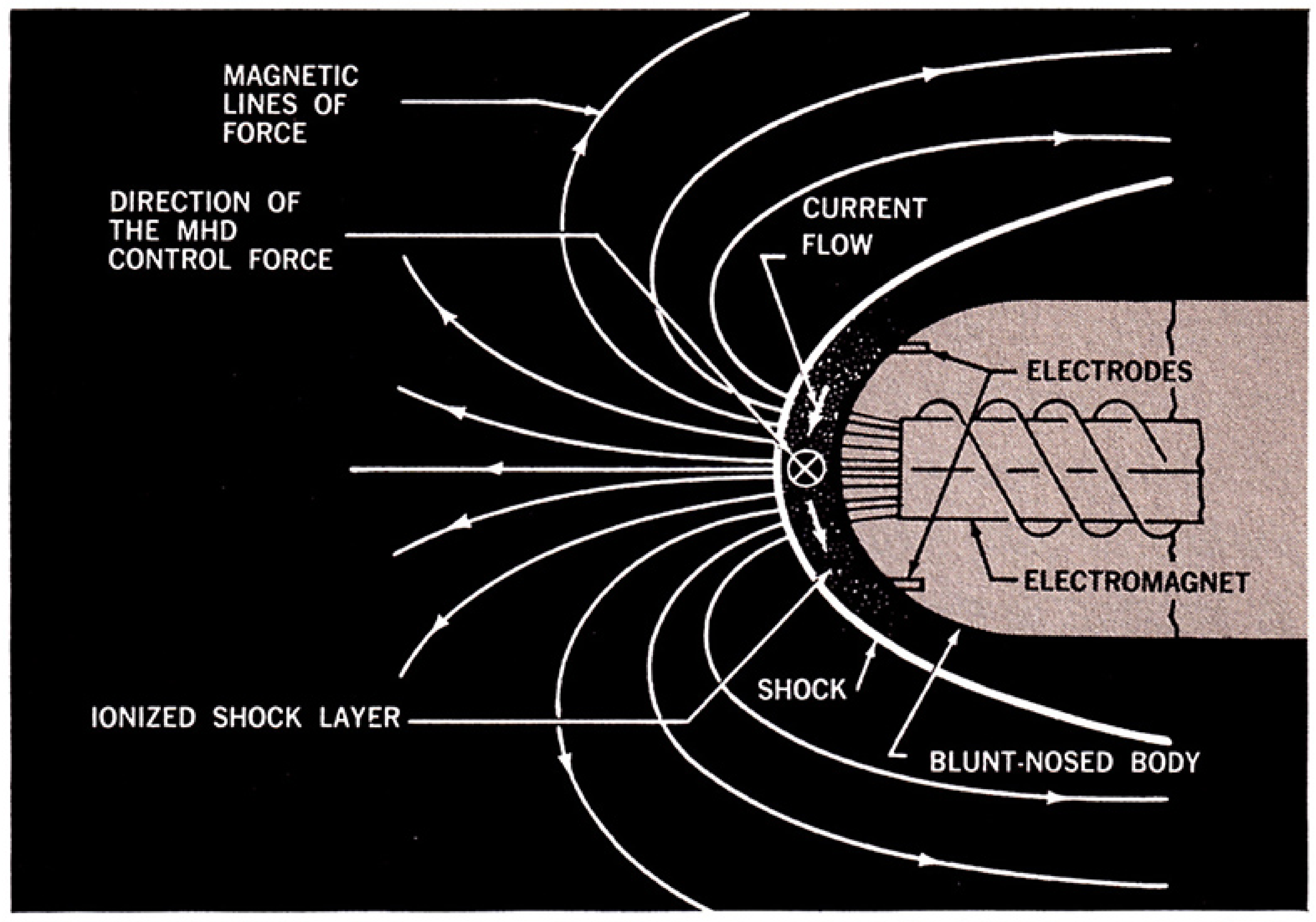
The hallmark of MHD and plasma physics is the Lorentz force, distinguishing them from classical fluid mechanics. Both the electric and magnetic fields exert this Lorentz force upon a conducting fluid, generally at right angles to both fields. A simple illustration is the electric motor. The motor is operated by the Lorentz force produced on the copper wires of the armature when you send electric current through them in the presence of a magnetic field. In MHD and plasma physics, an electrically conducting fluid or plasma takes the place of the copper wires. A common group of conducting fluids is the family of liquid metals. But for most MHD applications, the conducting medium is an ionized gas.

An ionized gas contains free electrons and ions (atoms which have lost or picked up one or more electrons. When you place an electrical potential across the gas, or whenever the gas moves through a magnetic field, current flows. Current flow interacting with an applied magnetic field produces a Lorentz force. Complicating matters, the current also produces its own magnetic fields.

There are many possible applications of research using these MHD principles to predict and experimentally examine the mechanical and electromagnetic interaction with conducting fluids. We will emphasize three areas of particular interest to Grumman:

- protection of space vehicles from re-entry heating,
- space vehicle propulsion,
- space vehicle flight control.

Examining the flow regimes of high-speed vehicles, we find that when a blunt body enters the earth's atmosphere at hypersonic speeds, a detached shock wave develops around the nose region. The gas behind the wave is heated to temperatures high enough (above 8000 degrees F) to vaporize any material.



INTERACTION *of forces of electromagnet in blunt nose of re-entry vehicle and ionized particles in shock layer could control flight attitude of spacecraft and reduce friction heat transfer.*

If, for example, the body is traveling at speeds about Mach 15 and at about 50 miles altitude, the ionized particles in the shock layer (the region between the shock and the body) will conduct current when a voltage is applied or when an induced electromotive force is generated by the flow of the conducting gas through a magnetic field. This shock layer current can interact with a magnetic field produced by an electromagnet installed in the body's nose. The interaction can generate forces within the ionized fluid which, in turn, are transferred to the vehicle. This transfer of forces is a consequence of Newton's law of action and reaction.

The net effect is an increased drag, a control moment, and/or a reduction in heat transfer. Visualize the last by imagining the magnetic field to seize and slow down the conducting fluid passing the vehicle's nose. The almost stagnant mass of fluid is then less able to transfer heat.

An added advantage which distinctly favors MHD control or heat transfer reduction is that the magnet used for control already may be on board to shield occupants from dangerous charged particle radiation. This hazard may come from such sources as solar flares or the Van Allen radiation belts.

Our own planet earth demonstrates on a grand scale that a magnetic field can deflect an oncoming stream of charged particles. Streams of electrons and protons from the sun (the solar wind) sweep toward earth, where our magnetic fields divert them around the earth at distances of about 40,000 miles. An on-board magnet can achieve a similar deflection.

Another MHD application, space propulsion, should

become a reality within the next few years. The chemical rocket produces high thrust for lifting a vehicle away from the immediate vicinity of earth. But once the vehicle is out in space, the MHD (plasma) engine appears to be a more favorable method of propulsion. The high specific impulse (thrust divided by rate of propellant consumption) of an electromagnetic propulsor makes it superior for extended flights, where propellant economy is the governing factor.

The variety of MHD and plasma engines is almost unlimited. The simplest classification is into two groups, one characterized by continuous operation, the other by pulsed operation. In the first group, a jet of plasma issues rather steadily from the propulsor. In the second, plasma is emitted in discrete blobs. Another classification compares MHD propulsors to ordinary electric motors, defining them as series (the Bostick button gun), shunt (the crossed-field propulsor), and induction (the traveling wave accelerator) types.

You can also use MHD principles to generate electric power on the ground. These generators are potentially more efficient than today's generators because they are not limited by the ideal thermodynamic (Carnot) efficiencies and because they do away with the need for intermediate equipment, such as steam generators and turbines. In the simplest scheme, hot ionized gas is forced through a magnetic field, generating an EMF (electromotive force) at right angles to both the gas flow and the magnetic field. This electric potential produces current flow in an exterior circuit.

This has been a brief review of some purposes and useful aspects of magnetohydrodynamics and plasma physics. But what of the supporting research and, in particular, Grumman's increasing theoretical and experimental efforts in exploring these phenomena?

In our Plasma Physics Laboratory we are investigating the properties of moving plasmas – specifically, we are determining the principles governing the generation, acceleration, guiding, and bending of the plasma.

Laboratory mechanisms can create several types of plasmas. One device Grumman uses is a puffer valve. It puffs a controlled amount of gas into an evacuated chamber or tube where electromagnetic radiation ionizes it. Upon ionization, a rapidly varying magnetic field accelerates the plasma to the order of 1/1000th of the speed of light. Other fields confine and bend the plasma after acceleration. Through investigations of the principles governing plasma action, we will gain knowledge for designing improved space vehicle propulsors, simulating the environment of outer space, and producing hydromagnetic shocks.

We have been examining hydromagnetic shock waves from a theoretical standpoint for several years. Visualize these waves as a current sheath separating regions of different density and pressure. They are the counterparts of such aerodynamic shock waves as are involved in the familiar sonic boom. Small amplitude MHD shocks, generally called "whistlers", have been detected traveling high above the earth's atmosphere.

A form of hydromagnetic shock can occur when a vehicle re-enters an atmosphere at extreme speeds. It's important we understand these phenomena more fully because they constitute real problems basic to the study of electrically conducting flows through magnetic fields.

The Research Department also is experimentally attacking the problem of MHD turbulence, an extension of common fluid turbulence. This is of great interest because it occurs in varying degrees in practically all magnetohydrodynamic devices. To implement this program, Grumman has acquired a 41-ton, iron-core electromagnet which can generate a 20,000-gauss magnetic field in a four-cubic-foot volume. This is 40,000 times stronger than the earth's field. The conducting medium for the turbulence investigation will be liquid mercury.

Grumman scientists have probed the feasibility of MHD control as part of an investigation for the Air Force. They sought to determine the magnitude of the interaction of forces occurring between the ionized gas surrounding a hypersonic vehicle and a magnetic field.

The latter research study at Grumman has been predominantly theoretical, although experimental work has been carried out in the Research Department's Hypersonic Shock Tunnel. Already, the theoretical studies have indicated several interesting possibilities for this type of nose control. The order-of-magnitude analysis determined the altitude-velocity regimes where appreciable electromagnetic forces are developed.

Preliminary results indicate that MHD flight control is most effective at superorbital velocities and at altitudes not higher than 50-60 miles, using strong magnetic fields and large nose dimensions. Initial experiments attempted to magnetically displace the shock wave in front of a hypersonic model. These experiments, the first of their kind to be tried in a shock tunnel, have not been conclusive, so far. If we succeed, we will seek experimental verification of the theoretical analysis.

Attempts to harness the Lorentz force are not without difficulties. A big problem in space flight propulsion and control is development of lightweight electric power supplies and circuit components. Difficulties in getting significant gas conductivities and powerful magnetic fields severely limit the useful range of operation. We may have to develop "seeding" techniques to raise electrical conductivity values in certain flight regimes. This may be done by introducing small quantities of easily ionizable substances into the flow.

the Gulfstream that NEVER FLIES

Seven-ton simulator gives piston pilots their turboprop wings, brings turbine captains up to peak proficiency

by Charles Spence

The whine of the two Rolls-Royce Dart turboprops rises in a muffled crescendo as Capt. Roberts pushes the power levers forward. Misty gray shrouds the cockpit windshields. Glancing at the rising airspeed needle, Roberts eases back on the yoke.

Rotate at V_r. Liftoff and accelerate to V_2. Gear up. Required speed. Retract flaps. Reduce power. Go through climb checklist.

Roberts climbs to 8500 ft on a standard instrument departure (SID) route. He's beginning to get the feel of the Grumman Gulfstream, to appreciate the difference between management of these sleek new turbines and the older piston powerplants so familiar to him.

Power settings for 500 fpm ascents and descents. Climbing turns. Holding pattern speeds. Complete familiarization with each flight regime.

For a couple of hours, Smith explores the Gulfstream's flight characteristics. Then, homeward bound, he calls LaGuardia Approach Control. Cleared, he lines up for a No. 1 Range Station Low-Frequency Approach to Runway 22. The "landing" is routine.

Actually, Smith never left the ground. These transition flights for corporate pilots checking out in the Gulfstream are being made in the first full Gulfstream simulator ever built. A year in the making at Link Div. (Binghamton, N. Y.) of General Precision Inc., it was installed recently at Flight Safety Inc. headquarters, Marine Air Terminal, LaGuardia Airport, New York.

More than 15 airlines, a dozen governments, and some 250 corporations send their pilots to FSI's eight training centers throughout the nation to gain and maintain peak pilot proficiency. The simulator was installed in line with FSI's motto that "The Best Safety Device in Any Aircraft Is a Well-Trained Pilot."

The Gulfstream that never flies is more than 18 ft long, nine ft high, and 20 ft wide and weighs about seven tons—nearly half as heavy as a fully loaded Gulfstream, itself. Its analog computer, 500 electronic tubes and 1500

miles of wire are fed enough electricity to power an entire New York City block.

Designed to fly within five per cent tolerances of its airborne counterpart, this electronic marvel reproduces the characteristics of both the aircraft and the powerplants so accurately that even the engine sounds are from recordings made during a Gulfstream flight.

Any Gulfstream pilot stepping into the simulator cockpit for refresher training finds himself right at home. The complete panel, control wheel—even the pilot seats—are all standard Gulfstream equipment. The cockpit design and color scheme were authentically created by Atlantic Aviation, Gulfstream distributors and aircraft interior specialists.

So complete and intricate is the simulator that it needs a larger crew than the Gulfstream, itself. In addition to the trainees, there are three FSI crew members: flight instructor with Airline Transport Rating in the G-159 Gulfstream, radio aids operator, and a full-time maintenance man to insure peak equipment performance and airline-type reliability.

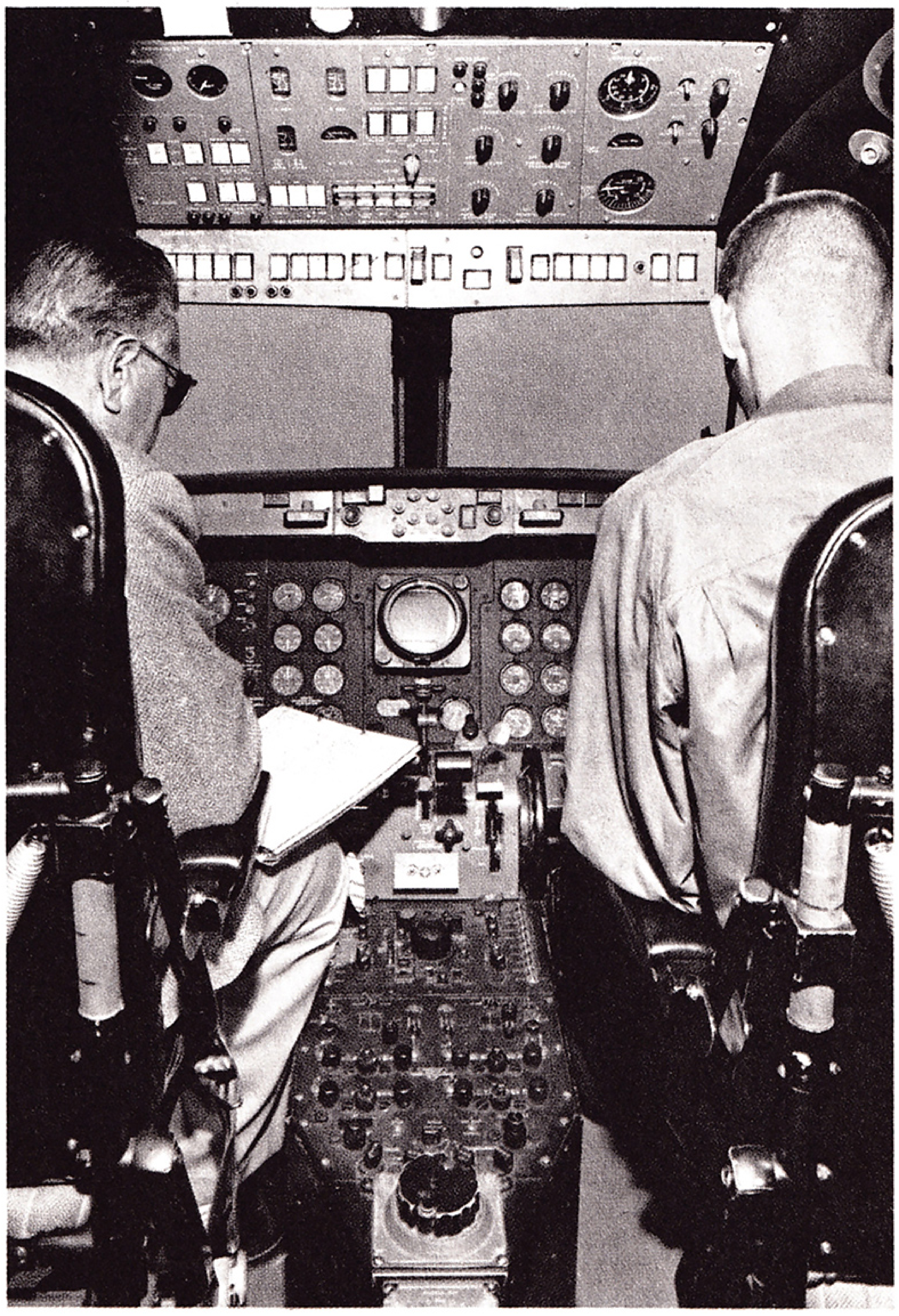
The simulator has exact Gulfstream aircraft systems. With an instructor at a special Trouble Panel, this is the safest and cheapest place to practice all emergency conditions. In flight in the actual aircraft, it's too risky to practice some of these.

The simulator also is an excellent and economic means of learning turboprop operation and of practicing and refining instrument flying techniques.

The separate radio aids unit houses a ground position recorder, the instructor's setup panel, and problem-solving electronic components. With this console, you can tune in four navigation facilities during the instrument training. Each nav facility can tune in VOR, ILS-GCA, homing, LFRR, or standard broadcast. These universal stations can be located at any position on the ground position recorder—either at a specific geographical location or in relation to other radio stations. The recorder automatically plots the ground track flown by the simulator. If you're practicing only aircraft operation, you can switch off the radio aids.

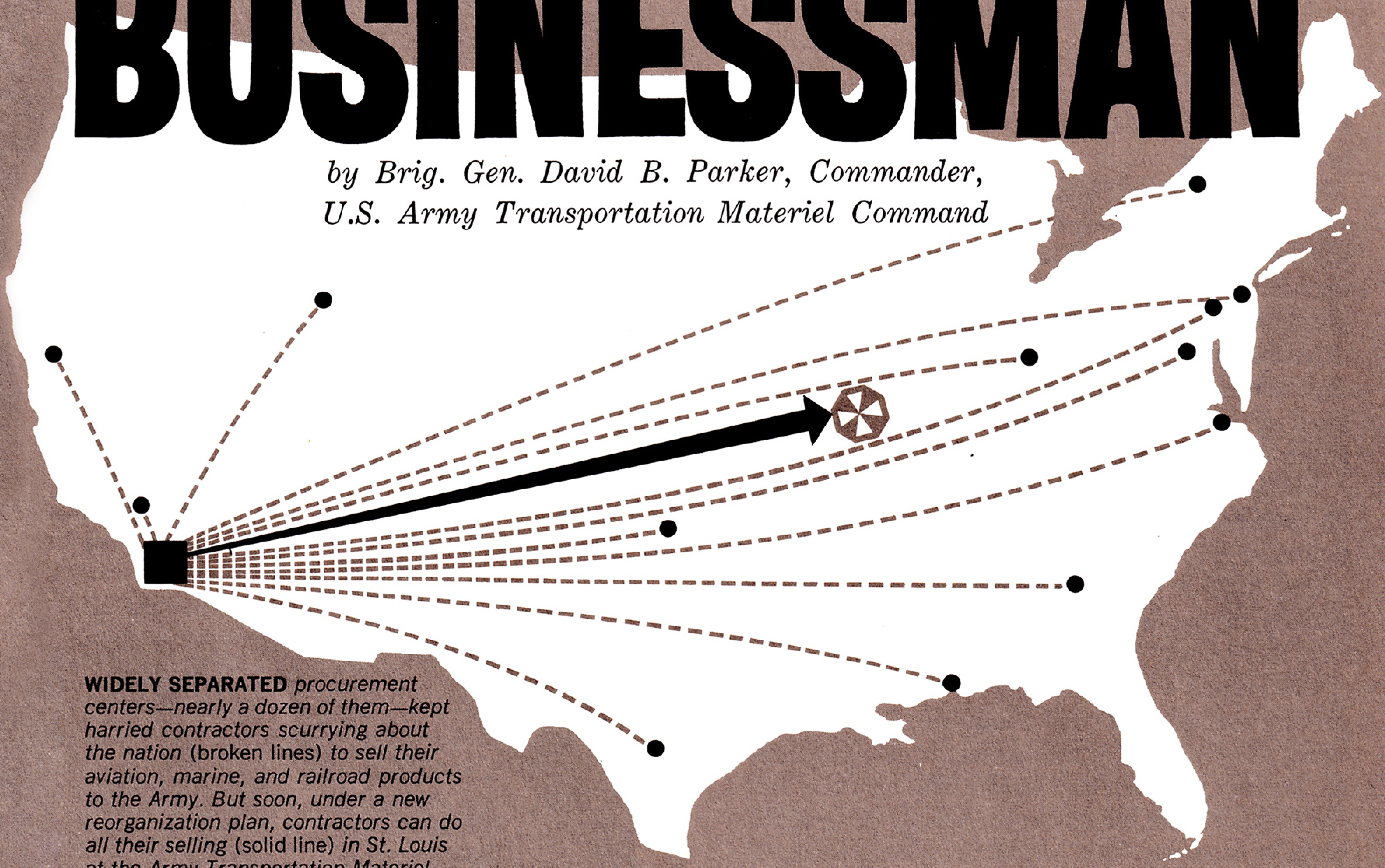
It's cheaper, of course, to get your training on the simulator than in an airborne Gulfstream. This is because you don't have any direct aircraft operating charges or aircraft maintenance problems caused by strenuous training maneuvers, and the company aircraft is kept free for hauling passengers instead of flying training missions. Another advantage is that you don't run into ramp delays or have to fly to low-density traffic areas for practice. The simulator flies in bad weather that would ground a Gulfstream. And when company Gulfstreams are sidelined for maintenance and overhaul, the crews can keep on "flying" in the simulator—using the time to brush up on ground as well as flight training. ■ ■ ■

INSTRUMENTS, *controls—even the pilots' seats—in the only full Gulfstream simulator ever built are the same standard equipment used in the aircraft, itself.*



THE ARMY AS A BUSINESSMAN

by Brig. Gen. David B. Parker, Commander, U.S. Army Transportation Materiel Command



WIDELY SEPARATED *procurement centers—nearly a dozen of them—kept harried contractors scurrying about the nation* (broken lines) *to sell their aviation, marine, and railroad products to the Army. But soon, under a new reorganization plan, contractors can do all their selling* (solid line) *in St. Louis at the Army Transportation Materiel Command.*

Businesses, large and small, will win billions of dollars in Army contracts this year . . . with fewer headaches than ever before

A massive reorganization of the Army's technical services went into effect last Aug. 1, with a planned period for full implementation of 18 months.

Though this reorganization has moved rapidly, perhaps even faster than originally estimated, it will take some months longer before the end benefits are fully realized.

One result of this reorganization is to place 50 per cent of the Army's total procurement under the Army Materiel Command *(see chart)*. Annual dollar volume of AMC procurement, covering 30 systems, will approximate $7.5 billion.

The technical service primarily responsible for providing and supporting Army aviation equipment prior to the reorganization was the Transportation Corps. Avionics equipment was supplied by the Signal Corps, weaponization by the Ordnance Corps, and certain selected parts by other corps such as the Engineers, Chemical Corps, etc.

Now the primary responsibility for all basically mobile equipment has been assigned to the Mobility Command, under the direction of Maj. Gen. Alden K. Sibley, with headquarters in Detroit. Field agencies of the Mobility Command include the Army Transportation Materiel Command

(TMC), the Army Tank Automotive Center, and certain related research, development, and engineering agencies and laboratories.

Complete materiel support of Army aviation equipment still is divided among several commodity commands under the Army Materiel Command (AMC). Airframes, engines, and related accessory equipment are the responsibility of the Mobility Command. This command has expenditures of some $2.5 billion per year and will buy approximately 58 per cent of the Army's federally cataloged or coded line items. The Mobility Command is largely delegated for operational responsibility to TMC.

Avionics equipment is supplied by the Electronics Command and aircraft weaponization by the Weapons Command, both commodity arms of AMC.

The Army is using two methods to solve, at least partially, the problems incident to multi-agency development and support of complex equipment.

One method is the designation of one agency as the primary manager of a type of equipment, with responsibility for coordinating the activities of other agencies as necessary to assure an adequate item for troop use. For instance, when an aircraft is primarily designed for utility or cargo use, TMC will be the systems manager, coordinating necessary avionics and weapons support with the Electronics and Weapons Commands.

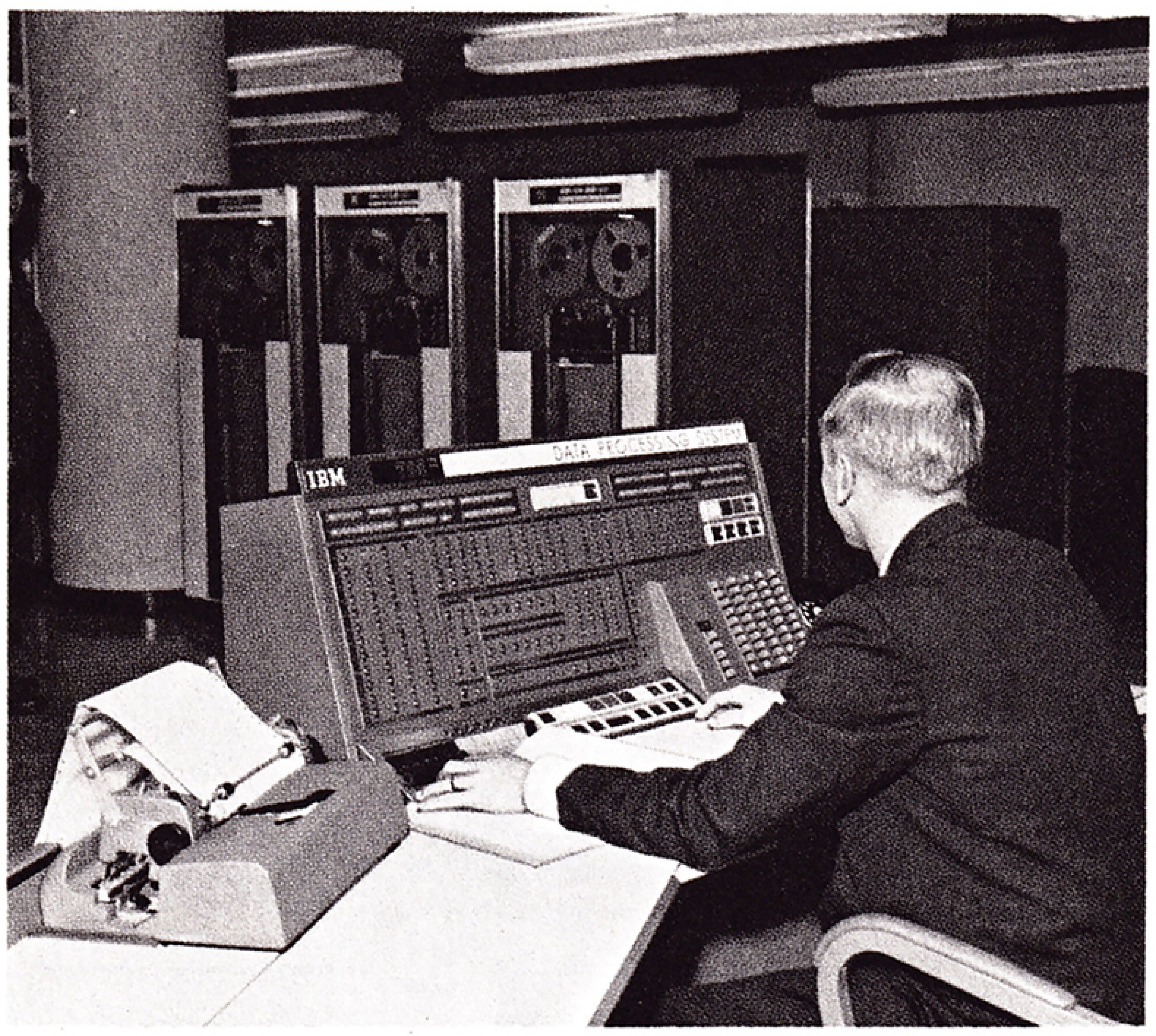
On the other hand, if an aircraft is to be used primarily for surveillance, with great emphasis on its avionics capability, the Electronics Command may be the systems manager—coordinating airframe, engine, and accessory requirements with TMC and weapons requirements with the Weapons Command.

The other device adopted by the Army to assure successful development, procurement, and support of top priority equipment is that of project management. Five types of aircraft have been selected for such management: the UH type produced by Bell Helicopter; the OV produced by Grumman Aircraft; the CV of DeHaviland of Canada; the CH of Vertol Division of Boeing; and the LOH type now in competitive development by Hiller, Bell and Douglas.

The project managers for each of these aircraft types are in Washington, D.C., on the staff of Lt. Gen. Frank S. Besson, Commander of AMC. They report to him directly, have red-line authority to seek his personal assistance in case of emergency failure of a program, and are held responsible by him for successful development and support of the aircraft type assigned to them.

However, the great bulk of the work needed to assure successful development, procurement, and support of these aircraft is performed by TMC in St. Louis. Most of the information required by the project manager to know the status of an aircraft type originates or rests in St. Louis. Communications between the project managers and their counterparts—the commodity systems coordinators in TMC—are virtually continuous.

A SENIOR ARMY AVIATOR *qualified to fly both single- and multi-engine aircraft, the author, 46, is shown at the controls of an Army (Beechcraft) L-23D Seminole light twin. Promoted to brigadier general last year, he was formerly R&D Director of the Army Transportation Corps. Gen. Parker was author of the Manhattan District Report on the Atomic Bombings of Hiroshima and Nagasaki. During WW II, he led the 1913th Engineer Aviation Battalion in the South Pacific. Gen. Parker was graduated third in his class of 1937 at the U. S. Military Academy and earned his Master's Degree in Civil Engineering at M.I.T. in 1940.*



LARGE COMPUTER *produces shipping instructions to Transportation Materiel Command depots where stock is warehoused. Magnetic tape consoles in background record some 90 fields of information for 300,000 items.*

In a sense, the project managers are the eyes and ears of AMC. Insofar as Army aviation equipment is concerned, TMC provides the arms, hands, and legs in this analogy.

TMC's funded program keeps these arms, hands and legs quite busy. During this fiscal year, the command will spend about $500 million for materiel, publications, services, and pay of employees. Of this sum, about $300 million will go for aircraft, amphibious, and marine and rail equipment. More than $100 million will be for spare parts, and $30 million for development of new aircraft systems to be procured on production items in future years. Another $70 million is for engineering services, contracts, publication services, and civilian payroll.

What does this reorganization mean to the aviation contractor? The goal toward which Army planners aimed was to put major procurement in the aviation field more nearly in one basket than heretofore. In the past, contractors have had to go to a large number of places to sell an item *(see map)*. These included nine Air Force Air Materiel Areas, the Air Force Logistical Command (formerly Air Materiel Command) at Wright-Patterson AFB, Dayton, Ohio; the Navy's Bureau of Weapons, Washington, D.C.; Navy Aviation Supply Office, Philadelphia; the Office of the Chief of Transportation, Office of the Deputy Chief of Staff for Logistics, Director of Army Aviation in the Office of the Deputy Chief of Staff for Operations, all in Washington; TMC; etc.

Under the new plan, it is contemplated that Army aviation procurement be centered in St. Louis, giving contractors one command with which to deal for aircraft and engine production contracts. These contracts include technical data, repair parts, ground handling equipment and other related items. Though not fully realized, this is the thesis of the reorganization—aircraft, marine, and rail procurement in St. Louis, tanks in Detroit, missiles in Huntsville, Ala., etc. Producers of equipment for sale to the Army may look forward to simplified methods of doing business with us.

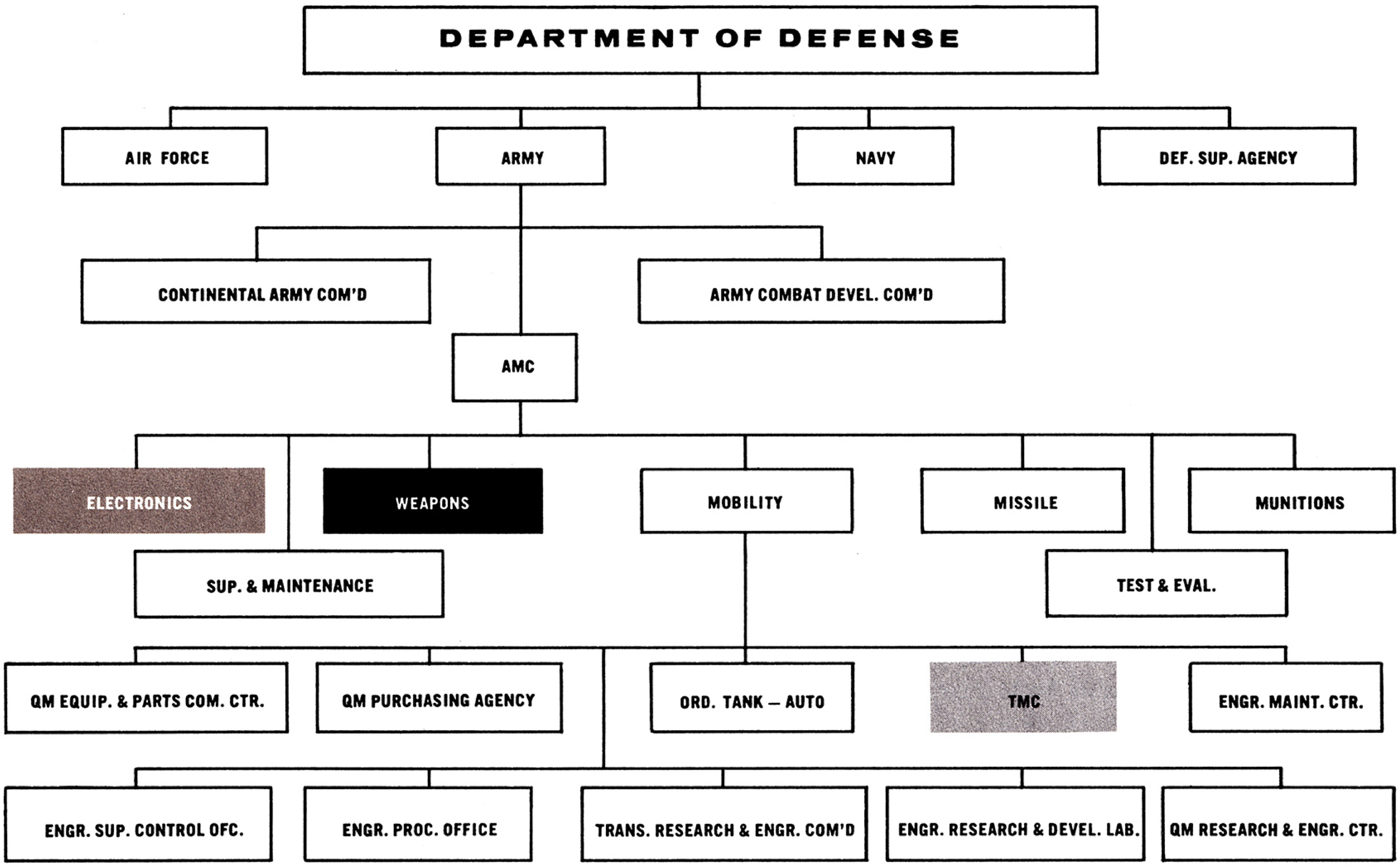
Owners of small businesses and those with limited sales forces may look to TMC for information on type of aviation and surface equipment and supporting parts in which the Army is currently interested in making procurement. To the extent feasible, all equipment and parts are procured competitively, with special emphasis on opportunities for small business and for placing procurement in labor surplus areas.

To foster this method of doing business, TMC holds procurement fairs, both in St. Louis and in selected industrial centers, at which drawings and sample parts are displayed. Any small business organization may bid on these parts, with the award going to the lowest bidder.

The only limitation placed upon this competition is that the selected bidder must have demonstrated capability to perform the contract to be executed. TMC satisfies itself of this capability by making plant and financial surveys before entering into contracts. This assurance of the ability to perform results, with few exceptions, in mutually satisfactory and beneficial relations between the Army and the contractor.

Many of the parts, tools, tests and ground handling equipment types of items procured by TMC are easy to manufacture, requiring little complex machinery or special skills. These range from canvas covers for small projections on aircraft, to provide weather protection, to a wide variety of machined and assembled metal parts.

SOME 85 PER CENT OF TMC's *$500 million budget is devoted to support of Army aviation equipment. Actually, TMC oversees spending of more than $1 billion a year. Shown above are TMC managers and their staffs for the Grumman OV-1 Mohawk.*



WHOM TO SEE *to sell to the Army is shown above. Project manager for aircraft such as Grumman OV-1 is AMC (Army Materiel Command) in Washington, D.C. Systems manager is TMC (Transportation Materiel Command) which also manages Army marine and rail equipment. TMC coordinates electronics and weapons support with those commands, indicated by brown and black shadings.*

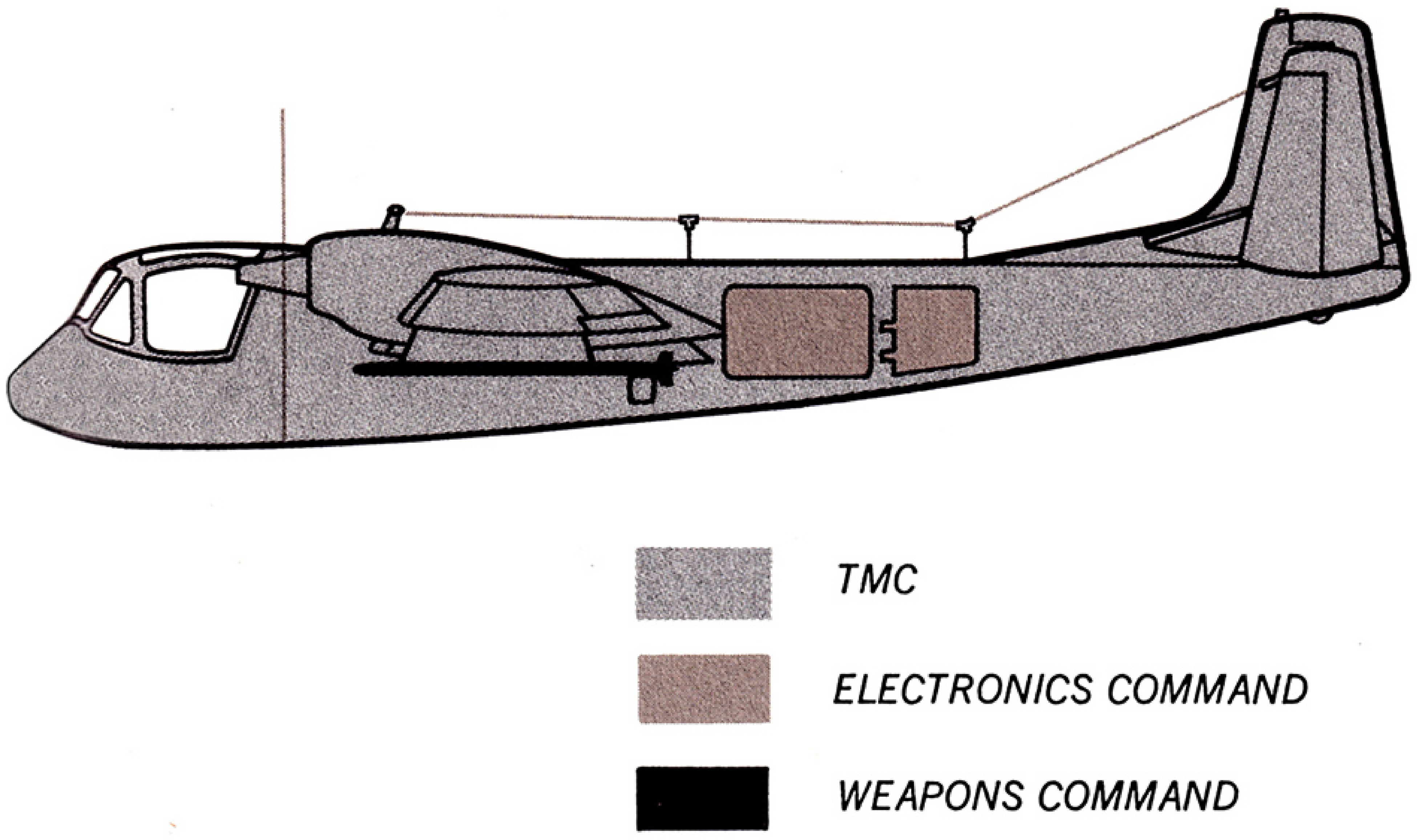
One the most important services provided by this command to the users of Army aviation equipment is that of quality assurance. Due to the high stress and low weight requirements for most parts for aircraft, quality must be a paramount consideration in procurement.

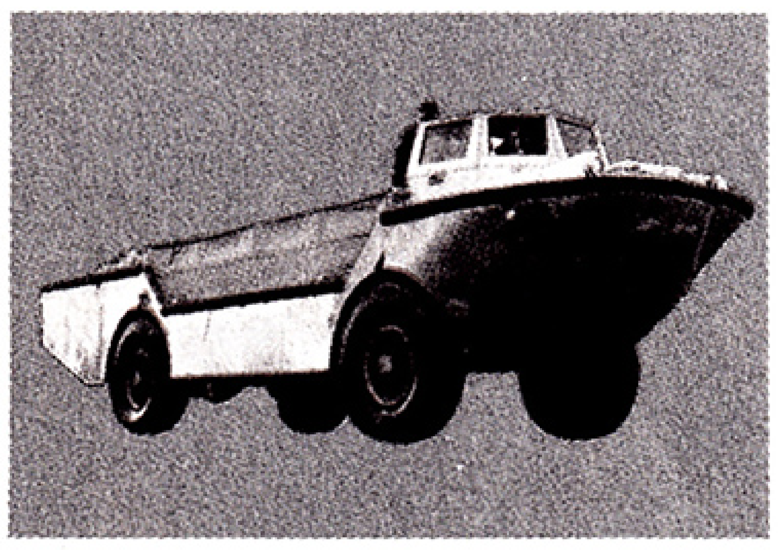
One method used by the command to assure quality is to provide precise specifications, drawings, and samples to prospective bidders. Materiel composition, processes, dimensions, and tolerances are defined with great care. Plant surveys assure the capability of the contractor to perform. Quality control requirements for adoption by the contractor also are specified. Test and acceptance may be performed in-process, at the contractor's plant of origin, or at the destination of storage or use. Packaging and care and preservation specifications are equally precise. Close attention by representatives of the command to quality requirements during all stages of procurement assure the user that the parts on which the safety of his aircraft depends are the best obtainable.

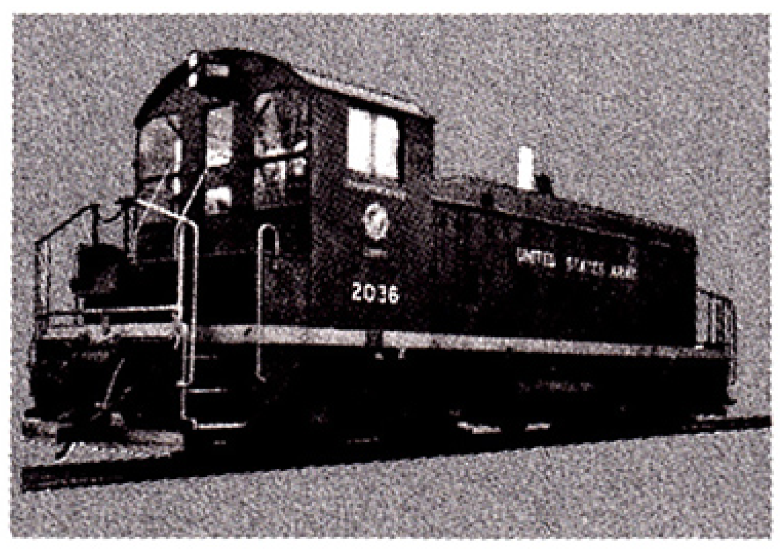
Engineering services performed by the personnel of the command assure the user of ever increasing reliability and maintainability of his equipment. A constant program of product improvement is pursued. Large strides have been made in dynamic components for aviation equipment which have satisfactory service lives.

Col. Earl Hauschultz, who was Director of Engineering for the command before he became its Deputy Commander, puts it this way: "Short-lived components impose economic and operational penalties on aviation equipment which the Army cannot afford. We are particularly sensitive to our need to be responsive to the requirements of our equipment for continuing improvement. Our goal is to provide equipment which will outlast the staying power of the crews during service."

Col. Arthur Ries, TMC Chief of Staff and a rated aircraft pilot, coordinates the activities of the operating, support, and service staffs of the command. "Responsiveness to other commands and to industry," he says, "has become a dynamic part of our way of life. Molding our staff to be responsive to the many demands made on us has been a real challenge. Our people are rising to this challenge. We are doing the impossible daily."







Another service this command performs for the users of Army aviation equipment is that of procuring, developing, and providing technical manuals describing inspection, maintenance, and manufacturing processes to be performed at all echelons in troop support. Appendices to each manual list the parts required to maintain equipment, while separate supply manuals are issued as a kind of mail order catalog containing all information necessary to permit users to requisition parts.

No parts are stored in St. Louis, nor is any maintenance or overhaul performed. Through depots operated by the new Army Supply and Maintenance Command, another of the elements comprising the Army Materiel Command complex, parts are issued and maintenance and overhaul are performed upon direction by TMC.

A depot overhaul facility was activated by this command in Corpus Christi, Texas, during 1960, and now has been turned over to the Army Supply and Maintenance Command for operation. This shop is devoted exclusively to the overhaul and emergency manufacture of aviation support equipment. About 40 per cent of all required overhaul for Army aviation equipment will be performed in the facility at Corpus Christi. The balance will be performed by contracts let by TMC.

The complex, worldwide responsibilities of TMC require many people and many skills. More than 3000 civilians are employed in Command headquarters, which has less than 100 military personnel, all of them officers. Among the civilian complement are engineers of virtually all specialties, procurement and production experts, supply control analysts, distribution and transportation personnel, catalogers, statisticians, operations research specialists, and a host of other skills.

In addition to the people doing the work of the command, a large computer *(see photo)* is used for data processing and integration. A record of some 90 fields of information for more than 300,000 items is maintained on magnetic tape. Requisitions for parts, run against the computer, produce shipping instructions to depots where stock is warehoused. The machine automatically maintains balance on hand, dues-in, dues-out, location and status of stock, standard prices, substitute and interchangeable data, and other information needed for control and distribution of inventories. It also computes requirements and produces millions of pages of reports.

Up to 85 per cent of TMC's budget, manpower, and effort is devoted to support of Army aviation equipment. Army aviation is being called upon to perform the impossible today. With a few thousand aircraft, half of which are more than 10 years old, the Army is providing aircraft for utility, cargo, transport, observation, surveillance, and support missions, weaponizing large numbers of aircraft, supporting the National Guard and the Mutual Security Programs, and assisting in military and civil emergencies. A goodly portion of the Army aviation fleet is deployed overseas, some in all theaters, and many aircraft are performing missions far beyond those for which they were designed originally.

Our guiding principle for now, and for as long as I am commander, is "Be Responsive". We must be responsive to the users of our equipment, to the contractors on whom we depend so heavily, and to the leaders who are guiding us in our transition to even greater air mobility in the Army.

NEWS IN BRIEF

BOTH QUANTITATIVE and qualitative testing is underway on the stabilization and control system of the Orbiting Astronomical Observatory (OAO). The tests are being run on Grumman's 2½-ton air-bearing table, so delicately balanced that the weight of a mosquito can tilt it. The NASA-Grumman OAO is scheduled for launching in 1964-1965.

THREE SENIOR VICE PRESIDENTS were recently appointed. They are: Llewellyn J. Evans, vice president since 1960; Richard Hutton, vice president since 1959; and George Titterton, vice president since 1955. Three new vice presidents are: Ira Grant Hedrick, chief technical engineer since 1955; J. B. Rettaliata, advertising and public relations director for the past 20 years; and A. James Zusi, chief aircraft engineer since 1955.

Drawing by Richard Decker; © 1958 The New Yorker Magazine, Inc.

INSTRUMENTED ANTHROPOMORPHIC DUMMIES will be marketed jointly by Grumman and Alderson Research Laboratory, Long Island City, N.Y., under a letter agreement between the two companies. In joint production of dummies for a customer, Grumman is the prime contractor, Alderson the subcontractor. Dummies are sold to governmental agencies, foreign governments, aerospace primes, and other commercial organizations for testing human survivability in hazardous environments or conditions.

EXPANSION OF SMALL BUSINESS SUBCONTRACTING Program at Grumman has resulted from Company's selection as prime contractor on the Lunar Excursion Module (LEM). For the first time in Long Island history, Grumman has set up a referral service to help local and other businesses compete for LEM subcontracts.

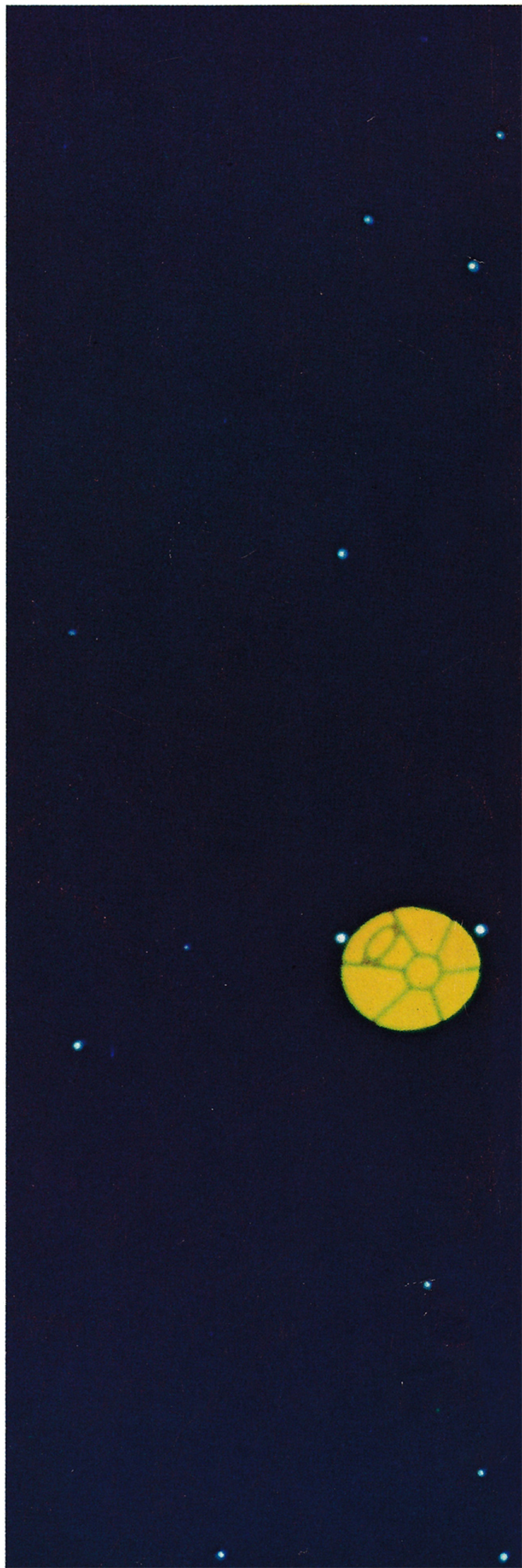
Grumman estimates about 50 per cent of the total dollar figure on LEM will be awarded to subcontractors. The initial prime contract on LEM is valued at $387,900,000.

DEDICATION of Grumman's $5 million Space Engineering Center at Bethpage was held in February, with George P. Miller (D-Calif.), chairman of the House space committee, as main speaker. Grumman now has invested more than $14 million during the past four years to improve its space-age capabilities.

THREE MORE WORLD RECORDS were claimed for the Grumman Albatross, which already officially holds six. The three claims, still to be approved by the world governing body for aviation records, were made by the Air Force. One is for a 153.7 mph speed record for amphibians carrying a 5000-kilogram payload over a 1000-kilometer closed course. The other two records claimed are for load and altitude, eclipsing two Russian records.

HISTORY-MAKING *aircraft carrier trials show Grumman E-2A Hawkeye making first nose-tow catapult launch from nuclear-powered Enterprise. Hawkeye is first carrier turboprop with fully pressurized fuselage and reversible propellers. Grumman A-6A Intruder (foreground) also successfully completed airframe trials from Big E off Norfolk, Va. Hawkeye is an early warning and intercept control aircraft, while Intruder is designed for all-weather attack.*


NAVY



GRUMMAN

AIRCRAFT ENGINEERING CORPORATION

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